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UTILIZATION OF FUEL IN BRITAIN

THE report of the Ridley Committee* is marked by a pronounced cleavage of opinion on one essential point and, in general rather than technical matters, seems to raise fresh issues as well as settle others. The report, however, contains many sensible and unanimous recommendations, and on the whole it carries us a step farther towards a national policy for the use of fuel and power resources. No government will, in future, be able officially to ignore the existence of a continuing rather than a temporary fuel shortage, and policy must be framed accordingly. Nevertheless, the Committee deals a shattering blow at any exalted ideas as to what can be achieved by central direction: its stricture, though implied, on the Ministry of Fuel and Power, is scarcely less severe than are its restrained comments on the warfare between the great nationalized industries which that Ministry is supposed to co-ordinate and which is displayed so frankly in the memoranda appended to this report.

The Committee was appointed to advise on possible measures to promote the best use of the fuel and power resources of Great Britain. It decided to interpret this as meaning that the general aims of a national policy should be: first, to meet in full the demands of the community for the different fuel and power services, when those services are sold at prices which closely correspond to the relevant costs of production and distribution; secondly, to provide for export fuels on such a scale and of such types as can be sold abroad with most gain for the country; thirdly, to promote the maximum economic efficiency in each use of each fuel; and to encourage the use for particular services of the fuel which gives the best return on the resources consumed. The first two of these aims raise questions of pricing policy, and the other two depend on comparative costs. Throughout the report, therefore, the importance of price policy is stressed. Furthermore, it is emphasized that all these aims must underlie a sound national policy at all times, even in the next few years when the gap between supply and demand makes it a first objective to divide what is available between different claimants so as to make the best use of it, and when immediate policy may require measures conflicting with the general aims of policy for the long run.

Reviewing first the prospects for fuel supply, on the evidence it examined the Ridley Committee expects a continued shortage of fuel and power in Great Britain. Future years may bring extra supplies from water, peat, wind and nuclear energy, but no significant return in power supplies is likely within the next few years from the development of power from ocean waves, the internal heat of the earth, solar heat, nuclear energy and other potential sources. Thereafter supplies should be easier, but it appears to the Committee that, to be able to meet in full prospective demands over the next decade, the National Coal Board may have to accelerate and expand its

* Report of the Committee on National Policy for the use of Fuel and Power Resources. (Cmd. 8647.) Pp. v+242. (London: H.M. Stationery Office, 1952.) 6*s*. 6*d*. net.

plans for future output. A certain complacency on the part of the Board in this respect left the Ridley Committee quite unmoved and, like Political and Economic Planning in its broadsheet last December, it considers that the Board's estimates of inland demand are too low and its production plans insufficiently related to national needs.

Measures to improve the efficiency of the use of fuel in the next few years are thus essential if the fuel needs of the country are to be satisfied, and in the longer run will always be important as a means of economizing resources. Many constructive proposals are made in the report in this connexion, and to a number of them the Committee attaches special importance. It recommends, for example, that new standards of performance based on achieving a room efficiency of the order of 40 per cent with coal should be determined for solid-fuel room-heating appliances, and it suggests a 100 per cent purchase tax for solid-fuel room-heating appliances and their parts which do not achieve these new standards. It recommends encouragement of the production of high-efficiency open fires of 'utility' pattern capable of easy installation in existing fire-openings and with convection heating and a restricted throat, as well as of simple devices for adapting existing fireplaces, and financial incentives for the installation of fires of the new standards and for improved insulation in new houses.

Subsidies for new house building and the granting of building licences offer obvious opportunities of encouraging such developments, and the Committee thinks that there is a sound case for the provision of some special financial incentive for firms to install fuel-saving equipment. It recommends expansion on more attractive terms of the present experimental scheme, announced by the Ministry of Fuel and Power last March, of government loans for approved fuel-saving appliances. Stokers, too, should be encouraged to raise their efficiency by arrangements for improving their status, and the Committee refers pointedly to the responsibility of government departments and other public bodies for taking the lead in promoting fuel efficiency, and to that of the Railway Executive for planning for increased fuel efficiency and accelerating trials of new forms of traction. A great increase in the service for providing industry with advice on fuel efficiency is recommended; but the Committee wisely emphasizes the responsibility of industry for solving its own fuel efficiency problems, and it recommends that industry should be invited to organize its own fuel efficiency advisory service to supplement that of the Ministry.

There are other sensible recommendations on which also the Committee is unanimous. In view of the greater efficiency of fluorescent lighting, it recommends removal of the purchase tax on fluorescent lighting tubes. The need for training in fuel technology is seen against the background of the general problem of technological education, and it recommends that measures for dealing with the general problem should take full account of this particular need, including the provision of financial aid. There are words for nationalized fuel industries which stress particularly the great importance of pressing forward the investigation of methods for the total gasification of coal, and the Committee lends strong support, as a help both to fuel economy and the export trade, of the early introduction of petrol with a higher octane rating. Unmoved by blast and counter-blast from the rival industries, the Committee notes the costs to the country of overloaded electricity capacity in a period of shortage, and the damage done at all times by smoke pollution, of which the domestic use of coal is a main source. Its impartial analysis of rival claims regarding domestic heating, which is rather kinder than some surveys have been to solid fuel, leads to the conclusion that no fuel or combination of fuels can be selected as the 'best' for domestic fuels in all or most or even 'normal' conditions; the main room-heating and winter-heating services in new houses should normally be provided by solid fuel directly burnt in efficient appliances.

This conclusion is reached on the ground of cost, and it is on this question of costs and prices, especially the price structure for coal, that cleavage of opinion appears. The Committee is unanimous that, from the point of view of the community, the price of coal should not be less than cost. Half of the Committee, however, believes that it should continue to be based on the average cost of production; the remainder would raise the price to cover marginal cost of production by imposing an excise duty of £1 per ton. Without entering here on the merits of argument and counter argument, it might be observed that the price of coal already appears to be sufficiently high to compel attention to fuel economy, and that the proposed excise duty is more likely to penalize the efficient user who has already eliminated waste than those whose extravagance leaves them with a margin for economy. Apart from this, such a proposal prejudices any attempt to devise a price structure based on the quality of the fuel.

It is not, however, this division of opinion that leads the Committee to reject some of the grandiose proposals for the formulation and co-ordination of national fuel policy which were suggested to it in evidence. The Ridley Committee prefers to use the price mechanism rather than physical controls on fuel consumption to achieve the desired ends, taking into account such factors as the expensiveness of electricity for domestic service at peak hours and its inexpensiveness off the peak. The small specialized Tariffs Advisory Committee, which it recommends should be set up to assist the Minister of Fuel and Power in his general control over the price policies of the nationalized fuel and power industries, is recommended to see that electricity tariffs discriminate, if possible, between peak and off-peak use, while the Committee also recommends that immediate steps be taken to make extensive practical trials of the various methods of measuring or controlling the consumption of electricity during peak hours.

Besides these, the Committee makes the important recommendation that full publicity should be given to the reports and recommendations of the proposed Tariffs Advisory Committee. It rightly attaches the utmost importance to public opinion being well informed on fuel- and power-pricing problems. This

is essential if there is to be ready acceptance of price structures determined so as to promote the best use of fuel and power. The Ridley Committee may have also had in mind the restraining influence of such publicity on some of the struggles between the fuel and power industries, and the manifest tendency of such vast monopolies to seek sectional rather than the national interest.

That is one of the most disturbing features revealed by the Ridley report, and it speaks well for the sound sense of the members of that Committee that they hold firmly and unanimously that the right policy, and indeed the only practicable one, is to leave the pattern of fuel use to be determined by the consumer's own choice between competing services. The Committee does not believe that direct intervention by the central government would be effective in improving the pattern of fuel use. Such intervention would unduly restrict the competition between the fuel and power industries, which it regards as one condition if 'freedom of choice' is to produce an economic pattern of fuel use. The 'rationing' of house-coal is accepted as necessary, but only for the present. This, moreover, is not the only factor militating against 'freedom of choice' at present; and the Committee also puts forward three conditions essential for competition to be effective in the desired direction. First of all, the prices and tariffs for fuel and power should correspond closely to the relevant costs of the particular services provided; secondly, the fuel industries should not impose on consumers any conditions of supply which may restrict their freedom of choice and are not justified by costs; and thirdly, full and objective information of fuel services and fuel appliances should be made readily available to the public.

It will be noted, too, that the Ridley Committee rests its hope for the success of the measures it recommends largely on the willing and continuing co-operation of all fuel users. This presupposes a considerable educational campaign. No doubt the Parliamentary and Scientific Committee will give early attention to this aspect; from that Committee may well come a lead to many professional bodies of scientific men and technologists who could give invaluable help.

There is scope, however, for more co-operation between the fuel and power industries themselves, and the Ridley Committee also recommends that the Ministry of Fuel and Power should establish a joint planning board through which the fuel industries could concert policy, with the assistance of the Minister. This board would be concerned essentially with the production and distribution of fuel and power. Its functions are conceived as embracing decision as to the selection of projects for investigation as possible joint enterprises, reference of the selected problems to the Board's staff for detailed study, the introduction of new projects to the fuel industries and possibly advising on the establishment of organizations to operate joint projects.

The Ridley Committee believes that such a planning board, in collaboration with the Scientific Advisory Council of the Ministry, would accelerate the application of the results of research, and secure necessary routine collaboration at all technical levels. In the last resort, however, the board would, the Committee observes, "depend on the Minister to ensure collaboration when one industry was unwilling to join in a scheme because its particular interests appeared to be prejudiced". Elsewhere, in rejecting proposals made in evidence for the establishment of a single statutory body with executive powers to co-ordinate the activities of the nationalized fuel and power industries as a whole, the Committee observes: "To the extent that co-ordination measures have to be imposed on the Boards (or on any one of them) that, in our view, is a matter for the Minister. In fact we look upon this function of co-ordination and of the control of policy as the main reason for the existence of a Minister of Fuel and Power".

This clear statement that it is the technique or will, and not the power, to co-ordinate that is lacking is an indictment of successive Ministers of Fuel and Power; it is also an indictment of the failure of Britain to deal effectively with the question of Parliamentary control of the nationalized industries, and indeed of the ability of Ministers to ensure that the nationalized industries are administered in the national and not in a sectional interest. That is a failure for which both major political parties must share the responsibility. The Ridley report throws into such strong relief the critical importance of an early solution of this problem of control for the implementation of national fuel policy that it is to be hoped that both political parties will join in the attempt to find a satisfactory solution. Much fresh constructive thought will be required, but given goodwill and an unprejudiced approach the task is not impossible. The Ridley report, itself marked by so much sense and moderation on controversial subjects, may possibly give a further impulse to such inquiry; without it there can be small hope of a national policy effective to eliminate waste of a precious resource, to mitigate domestic hardship and social inconvenience, or to remove the handicap to industrial expansion and economic recovery of which the Federation of British Industries has complained.

ATOMS AND AXIOLOGY

Philosophic Problems of Nuclear Science

Eight Lectures. By Werner Heisenberg. Translated by F. C. Hayes. Pp. 126. (London: Faber and Faber, Ltd., 1952.) 16*s*. net.

ONE summer evening in 1925, a small and very select meeting of theoretical physicists took place in one of the Fellows' rooms in Trinity College, Cambridge. It was a special occasion, and the host may even have 'sported his oak' meanwhile. A brilliant young mathematical physicist, fresh from Munich, Göttingen and Copenhagen, was about to expound his work in the field of atomic physics to a handful of people capable of appreciating it. The speaker was none other than Werner Heisenberg, before long to become a celebrity for his 'uncertainty

principle'. Subsequent events have added not only to his distinction but also to the debt which philosophers and scholars everywhere owe him for the profundity of his thought, and for the elegance of his expression. The present book does something to bring these things home to English-speaking readers. 'Something' is probably fair comment, for here is a collection of lectures, originally in German, translated with obvious sincerity but not always with complete *idiomatic* success. To this, some further reference will be made later in this review.

Meanwhile, with engaging humility, Prof. Heisenberg implies that his particular technique, though potent, was not the most beautiful, or even the most unusual. Yet concord upon all essentials concerning atomic configuration was achieved between his results—including the labours of his colleagues—on one hand, and those of Dirac on the other. Encouraging proof of the existence of "a bond unhampered", as Dilthey called it, in reference to seventeenth-century Paris, was near at hand.

History, however, does not repeat itself: these were no 'conversions' to mathematics such as that experienced by Hobbes, and brought about by the presence of Descartes. On the contrary, the twentieth century was to witness a forward surge by the specialists towards a deepening of physical science, and a fresh realization of its implications—for good or for ill—for all mankind.

The reader may well delight in the details elaborated in these eight lectures; but he will probably be the better rewarded if he takes them for what they are assuredly intended to be—an epistemology of Nature on the grand scale. An example (lecture 6) appears in the tracing of the beginnings of the modern era with Galileo and Kepler. Certainly there then existed a unified concept of Nature, namely, that conformable to Scriptural revelation. The aim of the men of science, in modern language, was "to find out God, and read Him everywhere". Later, however, as we all know, other motives gained the initiative.

Prof. Heisenberg brings his readers to the edge of the cliff in his last lecture. He almost invites them to look over and keep their heads. "The core of science is formed, to my mind, by the pure sciences which are not concerned with practical applications." Again, science *can* help international understanding, not because it succours the sick and so forth, but because it may direct our attention to a "centre" (call it what you will, the scholastics knew it as the *deus philosophorum*) in harmony with "the fact that the world is beautiful".

Now all this is exactly what one would expect from a mind of the author's calibre. He writes elsewhere of a region wherein science and art are scarcely separable, and, it might be added, "few there be that find it". This theme, laid before a university audience in Göttingen in 1946, was a brave confession to make before the Germany of that year. It may not be without influence over a wider company.

Philosophically considered, two questions arise. One is the relation of such a view as this to the scholastic doctrine of *analogia entis* (to which in structure it bears some likeness). The other is the marked contrast with the essential outlook of the great humanist architects, in the tradition of Vitruvius. They set out, deliberately, to build geometrically to the glory of God and erected many and great domes to declare His glory above the firmament. Taken together, the Thomist conception seems closer to that of Prof. Heisenberg—his "centre" and the visible world, while incommensurable, permit of a balance, enabling decisions to become real and living experiences.

The poise of the author's mind is perhaps best revealed in his treatment of the age-long Newton-Goethe conflict. This occupies practically the whole of lecture 5 and should be read as a worthy companion to the late Sir Charles Sherrington's Deneke Lecture of a few years ago.

In the result, the battle was not pointless, but it may be all too easily taken to be so if the dichotomy is not fully appreciated. For Newton, colour was to become an exact part of physics: Goethe was not wholly biased against mathematics, but he feared mathematical analysis and (for him) the destruction of the arena of sense-enjoyment. Yet, as Prof. Heisenberg remarks, the loftiest science and the poet's vision are not far apart. It is in passages like these that a rare quality of insight stands manifest, to fortify troubled mankind.

Nobody can expect discussions at this level not to suffer in translation (not to mention being wrenched out of the particular circumstances in which they were originally delivered), but certain easily avoidable blemishes are surely out of place. Examples are "experience" for "experiment", "apprehensible" for "comprehensible", and [mental] "deformation" for "deformity". They do not mislead, but merely annoy: one looks forward eagerly to their correction in a later edition.

In a sentence of impressive restraint (spoken at Göttingen), these lectures end with a precept akin to the famous one of Wittgenstein—"Whereof one cannot speak, thereof one must be silent".

F. I. G. Rawlins

CLINIC AND SOCIETY

The Psychology of Pierre Janet

By Elton Mayo. Pp. ix+132. (London: Routledge and Kegan Paul, Ltd., 1951.) 8*s*. 6*d*. net.

IT is much to be regretted that the work of the eminent French psychiatrist, Pierre Janet (1859–1947), was overshadowed during his lifetime by that of his greater contemporary Freud and, consequently, is little known in English-speaking countries. We are therefore grateful to the late Prof. Elton Mayo for his concise introduction to some of Janet's ideas. Prof. Mayo addresses himself, not to the student of medicine or psychiatry, but chiefly to students of social and industrial administration, and he confines himself to theories of Janet which are relevant to these areas of activity. His aim is to show how the clinical study of individual psychopathology may help us to understand how a person's social roles become disorganized. He is concerned, of course, with the psychopathology of everyday life, not the disorders of the psychotic safely tucked away in an institution.

Taking as his point of departure Janet's view that "social actions are the most complex human activity and that the costs exacted by adaptation to the individuals around us are by far the heaviest" (p. 90), he proceeds to trace the various ways in which obsession stultifies or distorts social action. He distinguishes two kinds of obsessive formula, one being "The world is hostile, let me attack it", and the other "The world is dangerous, I must be careful";

and he devotes his analysis mainly to the second, which he thinks is much more common.

His theme, accordingly, is the social and intellectual ineffectiveness of the obsessive person. Beyond a reference to the fact that Janet saw in the obsessive's difficulties a failure to develop in early life the skills necessary for ordinary social communication, the discussion avoids the etiology of obsession and attempts rather to elucidate its nature and effects. Since nearly every intelligent person suffers obsessive episodes from time to time, the personal and social disruption caused by them must be of interest to all those concerned with human organization.

Janet's interest in the study of hysteria led him to devise his "method of distraction" and to develop his theory of the dissociation of the personality into primary and secondary selves. Retraction of the field of consciousness and dissociation he held to be the two characteristic features of the hysteric. This work gave him an appreciation of the complexity of the attentive act and enabled him to describe with great insight the nature of obsession, though he realized that he was now dealing with disturbances of a different order. In his studies of obsession he shows that every successful act of attention presupposes an ordered background of contributory reflexes and skills. On the interplay between acts of attention and reflective thinking, which gives unity to experience, depends the capacity for decision and action. It is in the attentive act, according to Janet, that the obsessive's disability manifests itself.

The reader may be somewhat surprised to find that Prof. Mayo omits any reference to the work of the late H. S. Sullivan who, more perhaps than any other modern psychiatrist, succeeded in synthesizing many of the ideas of Freud and Janet. Janet's notion of retraction of the conscious field becomes, in Sullivan's hands, the "principle of selective inattention". Sullivan supplements this principle with his important theory of "prehension", or perception without awareness (which I have elsewhere suggested needs to be completed by introducing a concept of 'apprehension', that is, apperception without awareness). In the writings of Sullivan, Janet's ideas seem to have so far found their most astute elaboration.

JOHN COHEN

FISH AND FISHERIES OF AUSTRALIA

Fish and Fisheries of Australia

By T. C. Roughley. Completely revised and enlarged edition. Pp. xv+344+81 plates. (Sydney and London: Angus and Robertson, Ltd., 1951.) 50*s*.

MORE than thirty years ago, Mr. T. C. Roughley published a book entitled "Fishes of Australia and their Technology", illustrated with sixty-eight colour plates of common Australian fishes. That book has long since been out of print and unobtainable; but a continuing demand for it has induced the author to write a new and larger volume—"Fish and Fisheries of Australia"—which is now available. The publishers' description of the new book as a "completely revised and enlarged edition" of the former one seems scarcely accurate.

The book is in two parts. In Part 1 the occurrence, habits, edible qualities and commercial or sporting importance of more than a hundred and fifty kinds of fish are described in detail and there are brief references to many more. In order, no doubt, to keep the book within reasonable limits of size, little information is included from which identifications can be made; for this the reader must rely on the plates. These are all of very high quality; but they are relatively few in number, and the absence of precise descriptions of distinguishing features limits the value of the book.

Part 2 is concerned with the industry and sport. The annual value of Australia's total fish production is small—less than one-fiftieth of that of the United States. Mr. Roughley's explanation is that "the southern hemisphere lacks the vast concentrations of fish characteristic of northern hemisphere waters", although he also admits that Australian exploitation of her pelagic fishes could probably be greatly stepped up. He offers little hope of any great expansion of demersal fishing, for already some of the most important estuarine and offshore demersal fishing grounds are being overfished, and conservation rather than expansion must be the future policy. In fresh waters, pond culture, which has not yet been tried to any great extent, is believed to offer possibilities, and the fisheries departments of both New South Wales and Victoria plan to investigate them.

Many other fishery activities are dealt with, including shark fishing, big-game angling, spear-gun fishing and fish canning. An interesting final chapter briefly describes some native fishing methods, several of which are still practised by Aborigines in northern Queensland, where the influence of the white man has not yet penetrated.

The author has gallantly attempted to present an Australian rather than a State picture. The attendant benefits of using so broad a canvas more than outweigh the disadvantages—which are many—and the book should have a ready sale in Australia, despite its high price. It should, however, be supplemented as soon as possible by companion volumes dealing in much greater detail with regional fish faunas and their fisheries.

G. A. STEVEN

SURVEY OF HORMONES

Hormones

A Survey of their Properties and Uses. (Published by direction of the Council of the Pharmaceutical Society of Great Britain.) Pp. xii+220. (London: Pharmaceutical Press, 1951.) 35*s*. net.

THE publication of a volume of some two hundred pages, which sets out to survey the properties and uses of hormones for "pharmacists, medical practitioners, students and other interested persons", raises hopes of a general review which would necessarily be compressed but would bring together the scattered contributions from different branches of science to the problems of endocrinology. Perhaps no one man could successfully write all such a book, and it might have to be a composite production, under the guidance of an editor with the necessary breadth of view. This book, with four named contributors, seems to have had no editor other than the anonymous writer of the preface, which, ominously enough, begins with a quotation from Starling in which ὁρμάω is misprinted ὁρμάω.

The result is a collection of articles pitched at different levels, making independent approaches to different aspects of the same subject, entirely without

evidence of co-ordination. Many reiterations of summarized statements might have been avoided by cross-references, and an editor might have discovered, for example, that in spite of repetitive statements about propylthiouracil the chemical formula had not been given. The illustrations are a curious mixture of the frankly popular, such as the frontispiece, and the technical. Some of the sections are competently written; but each author seems to have had a different view of the educational level of his potential reader.

The chemistry of the steroid hormones is reviewed in the tight and abbreviated style associated with the "Annual Reports on the Progress of Chemistry" (and, rather surprisingly, the system of nomenclature is one abandoned by the Chemical Society four years ago). Dr. C. W. Emmens contributes a brief chapter on "Standardisation", but it is disappointing to find that in at least one instance, adrenocorticotrophic hormone, the information is far from up to date—in fact, less so than in the book on hormone assay which the same author edited and which was published in the United States in 1950. There is a section on "Action and Uses", perhaps necessarily superficial, and a chapter on "Pharmacy". The section on "Physiology" is an example of the worst type of scuffling and inaccurate compression. This may be illustrated by one quotation. Of the adrenal cortex it is stated: "Twenty-eight crystalline steroids have been isolated from the cortex. In 1934 Kendall *et al.* isolated a crystalline substance capable of maintaining the life of adrenalectomised animals. In 1936 Reichstein obtained from the adrenal cortex a sterol with androgenic properties which he named androsterone. Ingle isolated seven compounds which were effective in relieving different conditions associated with adrenal cortical deficiency, one of the most active being deoxycortone". It would be difficult to find a parallel to such a concentration of misrepresentations of facts.

It would be unfortunate if a book of this quality, appearing under the patronage of a scientific society of standing, should be taken to represent British knowledge and achievement in endocrinology.

R. K. Callow

PROTECTION OF COTTON IN PEACE AND WAR

Microbial Decomposition of Cellulose

With Special Reference to Cotton Textiles. By R. G. H. Siu. Pp. xi+531. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1951.) 80*s*. net.

FEW textile problems owe so much to the expansion of our knowledge of cellulose and the fibres of which it is the major component as the growth of micro-organisms on cellulosic textiles. It is only necessary to compare the information available when the Fabrics Co-ordinating Research Committee of the Department of Scientific and Industrial Research began, in 1920, the first organized attempt to ascertain the causes of decay of cellulosic fibres, and to assess the value of preventive measures with the extensive literature of to-day, in order to realize the progress that has been made in the intervening period.

In peace-time, the textile technologist is content to protect cellulosic textiles against the growth of moulds at the humidities and temperatures to be expected during transport to, and storage in, tropical climates. The conditions rarely permit the growth of bacteria or even of the moulds which decompose cellulose, so that his main concern is to prevent disfigurement. In service, chemical tendering by air, light and moisture is a more potent source of damage than microbial tendering, with the notable exceptions of fishing nets and lines and filter cloths.

In time of war, particularly in jungle warfare, use may be severe enough to reverse the relative importance of chemical and microbial tendering. This prospect has dominated the approach of the United States Army Quartermaster Corps to the problem of lengthening the useful life of textile equipment and has, naturally, tended to colour Dr. R. G. H. Siu's treatment of the subject. Nevertheless, Dr. Siu has earned the thanks of every worker in the field for undertaking the herculean task of summarizing a more considerable body of work than the title of his book would suggest. He covers successively the decomposition of cellulose in Nature; the structure and properties of cotton fabrics; the organisms which have been isolated from them; the microbial degradation of cellulose; and methods of preventing microbial attack, including chemical modification.

The description of the mechanical and chemical processes applied to cotton might have been omitted; it is unnecessary if the reader is familiar with textile technology, and inadequate if he is not. For the rest, either by choice or by force of circumstance, Dr. Siu has provided a comprehensive rather than a critical account. Thus, in Chapter 3 he stresses unduly the occurrence of chemical damage during the mechanical processing of cotton. In Chapter 4, the lists of cellulolytic and non-cellulolytic organisms would have been more valuable if the taxonomy had been brought up to date. In Chapter 5, it is not made clear why the humidity of the atmosphere surrounding a textile may be more important than its moisture content from the point of view of mould growth. More attention might also have been devoted to the greatly varying moisture requirements of different moulds, particularly as some of those which decompose cellulose develop freely only at a very high relative humidity. In Chapters 6 and 7, the comprehensive account of the mechanism of the degradation of cellulose is inevitably rather speculative, for many of the observations are contradictory and often lack adequate descriptions of experimental materials and techniques.

The remaining chapters (8–12) are accounts of methods of biological testing and of the prevention of microbial attack, either by the use of antiseptics or by conversion of the cellulose into suitable derivatives. The search for new antiseptics is described very thoroughly; the author's reliance on the soil burial test as the criterion of efficiency leads him, however, to reject treatments which have proved valuable for specific purposes and to accept treatments which may be open to objection on other grounds. As the soil burial technique is accepted as a satisfactory prediction of field behaviour, it is disappointing to find no assessment of the relative importance of microbial and chemical tendering in the many practical uses of cellulosic textiles.

Dr. Siu has provided a book of exceptional value to the specialist in any section of the field he has covered; its merit is enhanced by the very comprehensive bibliographies appended to each chapter. It is not, however, a book for the industrialist who seeks a ready guide to the solution of his problems.

The British National Bibliography Annual Volume 1951

Edited by A. J. Wells. (Published by the Council of the British National Bibliography, Ltd., British Museum.) Pp. ix+954. (London: J. Whitaker and Sons, Ltd., 1952.) £8 net.

THE objects of the British National Bibliography are to list every new work published in Great Britain, to describe each work in bibliographic detail and to give the subject-matter of each work as precisely as possible. The work is carried out at the British Museum by a team of fully qualified bibliographers. The first annual volume, which is classified according to the Dewey Decimal Classification, is provided not only with a full author, title and subject index, but also with a preface including some hints for tracing information which should smooth the path of the novice in bibliography. The fullest information about a book is given in the Subject Section; information in the Alphabetical Section is limited to author's name, short title, publisher and price.

The value of this Bibliography lies in the authoritative, full and accurate description of each book and in the detailed subject index, which facilitates the finding of books on the most specific subjects. On that it has met such tests as a leisurely examination and one person's experience has been able to apply, and its production appears to be reasonably in keeping with the scale and claims of the enterprise, though its price must restrict the use of the bibliography by the smaller libraries and by individuals. A few classes of publications, namely, cheap novelettes, periodicals (apart from the first issue of a new periodical and the first issue of a periodical under a new title), musical scores, maps, and the less significant Government publications, are omitted. On the last, the term 'significant' appears to be interpreted generously, for there are listed such minor papers as the White Papers on Higher Technological Education, issued last September, on the Future of the Overseas Food Corporation, and on Government Scientific Organization in the Civilian Field, as well as the annual reports of most departments or organizations of interest to scientific workers.

The Earliest Stages of Delinquency

A Clinical Study from the Child Guidance Clinic. By H. Edelston. Pp. vii+200. (Edinburgh and London: E. and S. Livingstone, Ltd., 1952.) 10*s*. 6*d*. net.

IT is now generally accepted that crime is the product of environment rather than inheritance. There are some factors—such as mental deficiency—which may be inherited and influence behaviour, but even with these good environment is able to prevent antisocial behaviour in the majority of cases. If environment is of such importance, it is essential that we should make the greatest possible effort to correct it as soon as there is evidence that it is having an evil effect on conduct. It is here that a child guidance centre is of such importance. The result of experience in this work is described by Dr. H. Edelston in his excellent book "The Earliest Stages of Delinquency". He states in the preface that "It is my claim that in this study I have introduced the new 'Psychiatric' approach without losing sight of traditional moral standards". In reality, it is doubtful whether any psychiatrist ever does neglect completely such standards, since he has to adapt his patient to society; but among the lay public the psychiatrist's emphasis on adjustment by removal of disrupting emotions rather than suppression of the personality in accordance with a moral code is sometimes misunderstood.

Dr. Edelston's book is divided into three parts. The first is concerned with the nature of misconduct and the use of the child guidance clinic; the second with treatment at home, by removal from home, and with those cases of severe characterological disorders which are unresponsive to the present modes of therapy. The third part is concerned with the actual administration of treatment and with practical procedures.

The author is the director of the Bradford Child Guidance Clinic, and obviously has had wide experience in this type of work. The book makes an excellent introduction to the problems of delinquency and should certainly be read by all who contemplate dealing with it. It would also be valuable to those interested more broadly in the nature of crime. If only such works were widely read we should have fewer wild statements on the imagined beneficial effects of pet remedies which have already been discarded as useless, and more real effort to cure those in need before they become hopeless recidivists.

CLIFFORD ALLEN

The Story of 100 Years of Phosphorus Making, 1851–1951

By Richard E. Threlfall. Pp. x+400 (58 plates). (Oldbury: Albright and Wilson, Ltd., 1951.) 25*s*.

FOR a century the firm of Albright and Wilson has been virtually the only maker of phosphorus in Great Britain, and the story of the introduction of the technical process, of its modification by the use of the electric furnace, of the collateral industries which have developed from it, and of the participation of the firm with others within the scope of its interests in two World Wars, could obviously make an interesting book. The task of producing such a book must have been difficult. Unpublished records and published material, personal details of the many who contributed to the success of the undertaking, and the traditions of the firm, have all been drawn upon. The associated companies, such as those at Niagara Falls and in Canada, come into the story. The book is well written and handsomely produced, the illustrations and plates, some in colour, being especially noteworthy. The book is interesting to read and also gives a valuable survey of an important branch of chemical industry.

Coal, Coke and Coal Chemicals

By Dr. Philip J. Wilson, Jr., and Dr. Joseph H. Wells. (Chemical Engineering Series.) Pp. ix+509. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 68*s*.

THIS volume is intended as a text-book for those interested in carbonization; but its main emphasis is on the coke-oven industry in the United States. It is for this reason that the book has limitations for those requiring a general survey, including British and European practice.

The early chapters deal with the combustion of fuels, the origin, classification and properties of coal, and with laboratory and small-scale tests for the selection of coking coal. Detailed descriptions and drawings are given of coke-ovens in the United States, followed by a review of the chemical and physical changes taking place during coking, and a survey of the properties of metallurgical coke. Useful tables are provided of statistics up to 1946 of the coke-oven industry and the disposition of products, and modern

trends are reviewed. In one appendix there is a list of all the carbonization plants in the United States.

About one-third of the book is devoted to the recovery and utilization of by-products. This section is informative and gives a very useful survey. The account of the gas industry is limited to some seventeen pages, and it is here that the book fails to give a balanced picture of modern gas-works practice. Reference is made to the growing interest in the United States in low-temperature carbonization; but processes operated within the United Kingdom are not described.

The book fulfils a useful purpose in reviewing the carbonization industry in the United States; it has endeavoured to cover a wide field in a limited space with considerable success. The printing and reproduction of diagrams and photographs are good.

A. C. Monkhouse

Tests for Colour-Blindness

By Prof. Shinobu Ishihara. (Published for Nippon Isho Shuppan Co., Ltd.) Tenth completely revised edition. Pp. 27+38 plates. (London: H. K. Lewis and Co., Ltd., 1951.) 75*s*. net.

PROBABLY the best known of the confusion chart tests for defective colour vision is the Ishihara series, in which the subject is required to read a number made up of coloured dots printed against a background of a different colour. By the appropriate choice of colours, the various charts have been designed so that the colour defective may either misread the number or fail to read any number at all. The charts may also be a guide to the type and degree of defect depending on the mistakes made by the subject.

During the Second World War. the charts were unobtainable from Japan, and Messrs. H. K. Lewis and Co., Ltd., produced an English edition which proved a very effective substitute. Now a tenth Japanese edition has been produced and is obtainable from Messrs. Lewis, who are acting as agents for the Japanese publisher, the English edition having been discontinued. The underlying principles of the charts are sound, and the merits of different editions depend on how successfully the quality of the colour-printing is maintained. Extensive tests carried out a few years ago in the United States showed significant variations between different editions, and only time will show how the new edition ranks with the old. In some of the charts the colours are darker and more saturated than in the earlier sixth and seventh editions, so that some inconsistency in the subject's reactions may appear. One or two new charts have been added which increase the versatility of the test, and perhaps, in a future edition, charts for testing tritanopia, the blue-green deficiency, could be included.

W. D. Wright

Name this Insect

By Eric Fitch Daglish. Pp. xxvi+294+64 plates. (London: J. M. Dent and Sons, Ltd., 1952.) 15*s*. net.

IDENTIFICATION of insects is a difficult subject for the non-specialist, the species being so numerous—more than twenty-one thousand in Britain—with many closely alike. Most popular books offer illustrated descriptions of a selection, through which laborious search is frequently necessary. "Name this Insect" is a notable attempt to make the search swifter and more direct.

Attractively written and produced, it begins with a simple exposition of structure and metamorphosis. There follows a key to major groups of insects; thence the quest is directed to the appropriate chapter, which contains a general account of the group, and a key to the adults of a good selection of species (more than seven hundred altogether). The keys are largely non-technical, and opposite each species is a brief description with notes on habits, habitat, etc. Most of the 430 or so illustrations, of which more than eighty are in colour, are good and many excellent, but some are a little inaccurate.

The book will be useful to those for whom it is intended, but there are two inevitable criticisms. First, if a convincing identification is not achieved, the inquirer does not know if this is because he has somewhere made a mistake, or because the species has not been included. Second, the designed simplicity and breadth of field of the keys entails a lack of precision, and identifications will sometimes be incorrect. Careful checking with descriptions and illustrations is essential, and, unless these clearly fit, specialist books should be consulted if certainty is desired. Unfortunately, a list of these is not provided.

B. D. Moreton

From Atoms to Stars

By Dr. Martin Davidson. Third edition, revised and enlarged. Pp. 280. (London: Hutchinson's Scientific and Technical Publications, 1952.) 18*s*. net.

EVEN a short compendium of modern astronomical facts, theories and methods must perforce be presented fragmentarily in so small a book as this one of Dr. Martin Davidson. Items that especially interest the author, such as atom structure, comets, meteors and tidal theory, are represented by larger fragments. The whole of the universe beyond our local galaxy receives but a small fragment, as does the subject of stars, other than Cepheids, which are intrinsically variable. Some fragments seem to be missing, notably the interpretation of spectra in the light of atomic physics, the principle of the spectrohelioscope and spectroheliograph and others on which so much present-day astronomical knowledge is based.

Nevertheless, in spite of an unbalanced effect, slips, misstatements and inadequate proof-reading, the book will help the reader whose interest in such matters has lapsed to bring himself up to date in certain particulars, especially if he is of a mathematical turn of mind. Assuredly the reader will not have to complain that this department is represented by an inadequate fragment; indeed, if he does as the author suggests in the preface to the first edition, and checks the mathematics for himself, he may spend some profitable hours.

Commendable features are the bibliography and the index.

F. M. Holborn

Chymia

Annual Studies in the History of Chemistry. (Edgar F. Smith Memorial Collection.) Vol. 3. Henry M. Leicester (editor-in-chief). Pp. ix+251+15 plates. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1950.) 36*s*. net.

THIS volume contains thirteen papers dealing with various aspects of the history of chemistry and alchemy. Those on Lavoisier's apparatus, early American chemical societies, and on a comparison of Boyle the chemist and Bayle the historian, may be mentioned as examples of the wide range of interests. The publication has taken its place among the journals dealing with the history of chemistry, and the standard of the articles is being maintained.

CONSTITUTION OF COAL AND THE FORMATION OF COKE

By Dr. W. A. KIRKBY and Prof. R. J. SARJANT, O.B.E.
Department of Fuel Technology, University of Sheffield

A PRELIMINARY investigation here described, which was initiated in this Department in 1947 and carried out by D. K. Datta, is concerned with the constitution of coal from the point of view of the mechanism of coke formation and forms part of a wider co-operative series of researches including experimental studies in carbonization and coke properties.

Four coking-coal slacks were selected for study, each being of similar ultimate composition but forming cokes which were known to have shown considerable differences in behaviour in industrial practice, particularly by their use in blast furnaces, cupolas and lime-kilns. The composition of the coking slacks is given in Tables 1 and 2.

TABLE 1

Coking slack	Coal seam origin	Colliery	Ash-free dry composition (per cent) Carbon	Hydrogen	Nitrogen	Sulphur	Oxygen (diff.)	Gross calorific value
A	Blend of Brockwell and Busty seams	Langley Park, Durham	87·50	5·05	1·60	0·95	4·90	15,530 B.Th.U./lb.
B	Lower Mountain Mine	Scaitcliffe, Lancs.	86·75	4·90	2·00	0·45	5·90	15,370
C	Upper Mountain Mine	Moorfield, Lancs.	84·75	5·15	2·35	1·30	6·45	15,130
D	Blend of Barnsley and Parkgate seams	Thurcroft, S. Yorks.	84·50	5·50	1·85	1·75	6·40	15,010

TABLE 2

Coking slack	Moisture (per cent)	Ash (per cent)	Volatile matter, ash-free dry (per cent)	B.S. swelling No.
A	1·1	9·1	29·4	8½
B	1·5	5·7	30·9	8
C	1·8	10·9	34·1	7
D	1·4	6·8	36·6	7

The general method used is that of selective solvent extraction of coal under such conditions that as mild a resolution as possible is obtained. The experimental procedures adopted comprise: extraction of the coals with phenol, pyridine and other organic solvents, and of these extracts further with chloroform, in an atmosphere of nitrogen; chromatographic separation of the latter extracts on activated alumina, eluents used including chloroform, benzene, acetone and *n*-hexane; and infra-red absorption spectrometric analysis of the extracts and elutes. The effect of ultrasonic fields[1] of various characteristics upon the extraction of the coals is also being studied.

In Table 3 values are given showing the relative properties of cokes prepared from these slacks in an experimental oven in the Department and also of the commercial cokes. The 'degradation factor' is an index of the physical properties of coke, obtained by the use of a variable-impact shatter machine, and is expressed as the percentage degradation per ft.-lb. of impact energy applied. The values given in the table were obtained in these laboratories by J. E. Littlechild, who developed this impact test for measuring the 'hardness' of coke. It was found, however, in an investigation of the relation between carbonizing conditions and the physical properties of these cokes as assessed by this impact test, that the so-called 'hardness' of a coke was affected to such an extent by variation of carbonizing conditions and the position of the actual sample of coke in the oven that the inherent influence of the coal in determining such properties could be masked.

In determining the reactivity by a new method it was found that the parentage of the coal in the coking blend was more definitely related to the reactivity as determined by this method. The reactivity values given in Table 3 were obtained by S. Banerjee and R. J. Sarjant[2] in another investigation in the same series of researches, using a modification of a method suggested by A. C. Dunningham as used in the laboratories at Winnington of Imperial Chemical Industries, Ltd., in which coke is burnt in a sized bed with air supplied at a standard preheat to ignite the bed, the temperature of which is controlled by an external heater. The reactivity is expressed in terms of the ratio of the actual carbon found in the gases to the theoretical maximum carbon content which would be obtained by complete conversion of the carbon dioxide to monoxide, and based in both cases on unit volume of air supplied.

Solvent extraction of the coals. For the present experiments phenol was chosen as the solvent, as it can be obtained in a high degree of purity and can be comparatively easily removed from the extract. Moreover, it has a high internal pressure of 120 cal./ml. at 150° C. and may therefore be expected to give a relatively high yield of extract. The coal samples were ground to pass a B.S.72 mesh sieve, and the extractions were carried out in an atmosphere of nitrogen in a Soxhlet apparatus devised by W. A. Bone and R. J. Sarjant for their researches on coal[3]. Extractions carried out up to 240 hr. gave 31–38 per cent of extract; and as there appeared to be no limiting value of the yields up to that time of extraction, it would seem that the process is not

TABLE 3

Coking slack	Cokes prepared in an experimental oven, carbonizing temperature 1030–1250° C. Degradation factor	Reactivity	Commercial cokes Degradation factor	Reactivity
A	$4·2–5·0 \times 10^{-2}$ *	0·606–0·612	$3·50 \times 10^{-2}$	0·573
B	$3·12 \times 10^{-2}$	0·666	$6·73 \times 10^{-2}$	0·642–0·664
C				
D	$2·68 \times 10^{-2}$	0·629	$4·63 \times 10^{-2}$	0·592

* Under the experimental conditions of coking, the full mechanical properties of this coke had not been developed.

merely one of solution, but of depolymerization as well. In a few experiments applying an ultrasonic field (frequency 650 kc./s.) to the coal–phenol mixture, with the coking slack *D*, whereas 35·8 per cent of extract was obtained under the ordinary conditions after a period of 240 hr., after 2 hr. at 50° C. with the field applied the amount of extract was increased to 39·9 per cent.

The phenol extracts (after 240 hr.) were then resolved further by extracting with chloroform, and similar yields of soluble (14–19 per cent on the original coal) and insoluble (16–21 per cent) fractions were obtained for all the coals examined.

Chromatographic separation of the chloroform-soluble extracts. Activated alumina was used for effecting a chromatographic separation of the chloroform extract. After percolation of the solution through the column, it was developed by means of chloroform. There were formed: (i) a narrow yellow zone, about $\frac{1}{8}$ in. in depth; (ii) a zone about $\frac{3}{8}$ in. with a gradation of colour from bright yellow to dark brown; (iii) a greyish-brown zone about $\frac{1}{8}$ in. deep; and (iv) a deep-brown zone of about $\frac{1}{2}$ in. in depth. Liquid chromatograms were then prepared by eluting with different solvents as follows: chloroform, (i) light-yellow solution from the yellow zone, (ii,*a*) dark-red solution with green fluorescence, (ii,*b*) light-yellow solution; benzene, (iii,*a*) dark-red solution from the grey portion of the greyish-brown zone; acetone, (iii,*b*) from the brown portion of the greyish-brown zone; and *n*-hexane, (iv) from the deep-brown zone.

Infra-red absorption spectrometric analysis of the chromatographic fractions. The instrument used for this purpose was a non-recording Hilger infra-red spectrometer *D*223, with rock-salt prism and absorption cells, and photoelectric relay amplifying galvanometer system. The equivalent slit-width for the range 2·5–15 μ varies from 0·08 to 0·42 μ.

Table 4. Absorption Bands common to the Four Coals

Eluent	Position of bands
n-Hexane	2·95–3·10 μ
Acetone	4·05–4·10
Chloroform	4·40–4·50
n-Hexane	5·9– 5·95
Acetone for coals *A*, *B*, *D*	8·40–8·45
Benzene " *C*, *D*	
Acetone " *A*, *B*, *C*	8·55–8·65
n-Hexane " *D*	
Chloroform " *A*, *B*, *D*	10·20–10·35
Benzene " *C*	
Acetone " *A*, *D*	11·0–11·20
Benzene " *A*, *B*, *C*	12·05–12·20
Benzene	

Table 5. Other Absorption Bands

Eluent	Coal *A*	Coal *B*	Coal *C*	Coal *D*
Chloroform	2·55, 4·7–5·45, 7·4 9·15, 10·30, 13·7 μ	2·6, 5·50, 6·30, 9·15 μ	5·20, 5·50, 6·15, 6·80, 14·70 μ	3·70, 4·45–5·4, 5·60, 5·9, 6·1 7·4, 9·1 10·35 μ
Benzene	4·55, 6·05, 8·7 10·1, 13·65, 14·20 μ	4·65, 12·65, 14·15, 14·45 μ	4·05, 4·65, 13·85 μ	6·05, 12·6, 13·2, 13·7 μ
Acetone	6·95, 8·05, 8·60, 12·35, 14·15 μ	3·10, 6·20, 7·90, 8·65, 9·0, 9·45, 10·40, 11·60 μ	3·10, 7·85, 8·60, 11·60, 12·50 μ	6·80, 7·75, 11·65, 12·40 μ
n-Hexane	3·35, 9·25, 10·05, 13·55, 14·05, 14·35, 14·80 μ	3·15, 5·0, 5·25, 9·25, 10·05, 10·80, 11·60, 12·7, 14·30 μ	7·65, 10·05, 11·60, 12·70, 13·55, 14·20, 14·40, 14·80 μ	10·70, 13·60 14·00. μ

The chloroform extracts and chloroform, benzene, acetone and *n*-hexane elutes were examined for their infra-red absorption spectra. There were found to be very few bands in the spectra of the chloroform extracts for differentiation of the four coals.

In the chromatographic elutes, however, numerous absorption bands have been distinguished and tentatively identified, and among them are several which may be used for differentiating the coals. The four eluents used differ considerably in their chemical character, and there is, as may be expected, a large degree of selectivity shown by these eluents in respect of the absorption bands revealed in the different elutes of any one coal. An analysis of the spectra given by the various elutes is given in Tables 4, 5 and 6.

There is to be considered the possibility that the differing proportions of phenol – chloroform-soluble material extracted from the coals may be reflected in the differences between the coals as indicated by the absorption spectra of the elutes. If that were so, the relative amounts of material extracted would lead to the expectation that coals *A*, *B*, *D* would show considerable similarities in their absorption spectra and that coal *C* would differ appreciably from them. A comparison of absorption bands common to different groups of three of the coals shows that the number of similarities in the group *A*, *B*, *D* is not significantly greater than in any other group.

In view of this, there seems at least a *prima facie* case for dividing the coals into two groups—*A* and *D*, *B* and *C*— on account of the considerable number of absorption bands which are common to the coals in each group respectively, as shown in Table 6.

From the information available[4] on the interpretation of infra-red absorption spectra of organic molecules, the chemical groups in the chromatographic fractions shown in Table 7 may be tentatively identified from the position of some of the absorption bands, neglecting their intensities.

In the large number of bands between 9 and 14 μ, the skeletal absorption region, there appear to be some which are characteristic of benzene substitution and condensed aromatic systems.

A notable feature so far is that the differentiation into groups, based on the absorption spectra of the coal extract elutes, is matched by a differentiation of the coals in respect of the properties and behaviour

Table 6. Differentiating Absorption Bands

Eluent	Coal *A*	Coal *D*	Coal *B*	Coal *C*
Chloroform	4·7–5·45, 7·4, 10·30 μ	4·45–5·4, 7·4, 10·35 μ	5·5 μ	5·5 μ
Benzene	6·05, 13·65 μ	6·05 13·7 μ	4·65 μ	4·65 μ
Acetone	12·35 μ	12·40 μ	3·10, 7·90 μ	3·10, 7·85 μ
n-Hexane	14·05 μ	14·00 μ	11·60, 12·70 μ	11·60, 12·70 μ

Table 7

Band (μ)	Group	Band (μ)	Group
2·55, 2·6	OH	5·9	C = O (in acid form)
2·95–3·10	OH and/or NH	6·05	C = C or C = O
3·15	CH (unsaturated) or NH	6·1, 6·15, 6·20, 6·30	C = C (conjugated; aromatic)
3·35, 3·70	CH	6·8, 6·95	CH_3, CH_2 (deformation)
4·05–4·10	NH or SH ?	7·4	OH (deformation)
4·40–5·45 (complex)	multiple bonds	7·9, 8·05	= C—O
5·5, 5·6	C = O (in ester or anhydride form)		

of the cokes made from them. As judged by the figures given in Table 3 for the degradation factor and reactivity for both the commercial cokes and those prepared in the experimental oven, it will be seen that (with the exception already noted in Table 3) the cokes from coals *A* and *D* have lower values than those from coals *B* and *C*, that is, the former pair of coals give the harder and more unreactive cokes. Moreover, as regards the relative behaviour of the cokes in industrial practice, those made from coals *A* and *D* give a very hot and narrow zone in high-temperature shaft furnaces, as compared with a wider and not so hot zone with the cokes from coals *B* and *C*, as well as a higher temperature in cupolas.

From the results obtained so far in these preliminary experiments, it would appear that by the use of these techniques there is possible a differentiation of coals in respect of at least some of the properties of the cokes produced therefrom. A considerable number of coals are now being investigated to see if there can be found in this way an understanding of the fundamental differences in coals which affect their coking properties.

[1] See Berkowitz, N., *Nature*, **163**, 809 (1949).
[2] Banerjee, S., and Sarjant, R. J., *Fuel*, **30**, 130 (1951)
[3] Bone, W. A., and Sarjant, R. J., *Proc. Roy. Soc.*, A, **96**, 119 (1919).
[4] For example, "Infra-Red Determination of Organic Structures", by Randall, H. M., Fowler, R. G., Fuson, N., and Dangl, J. R. (D. Van Nostrand Co., Inc., New York, 1949). Cannon, C. G., and Sutherland, G. B. B. M., *Spectrochim. Acta*, **4**, 373 (1951). Sutherland, G. B. B. M., Discuss. Farad. Soc., No. 9, 274 (1950).

FIRST INTERNATIONAL CONGRESS ON ANALYTICAL CHEMISTRY, OXFORD

THE First International Congress on Analytical Chemistry, under the patronage of the International Union of Pure and Applied Chemistry, was held at Oxford during September 4–9, with Sir Robert Robinson as president. The Congress consisted of twelve sessions, at which forty-three scientific papers, under nine subject groups, were read and discussed, and of four Congress lectures. There were also a trade exhibition of instruments, apparatus and books, and an exhibition of analytical techniques and apparatus.

The success of the meeting was assured from the start by the attendance of about seven hundred chemists from all over the world, some of whom were also able to attend meetings of the Section Committee and Commissions of the Analytical Chemistry Section of the International Union before and after the Congress. The success of the Congress was a worthy tribute to the organizers, the burden of the work falling on Mr. R. C. Chirnside, whose ability was reflected in the smooth running of all the proceedings.

The first of the Congress lectures was given by Prof. I. M. Kolthoff, of the University of Minnesota, who spoke on the "Ageing of Crystalline Precipitates". The 'ageing' to which Prof. Kolthoff referred denotes the irreversible structural changes that occur in a precipitate after it has been formed, of which the classical 'Ostwald ripening', the growth of larger particles at the expense of the smaller, is an example.

Dr. R. H. Müller, of Los Alamos Laboratory, New Mexico, an authority on the subject of instrumentation, spoke on "Research in Analytical Instrumentation". His lecture was not a mere summary but reviewed the possibilities for the future. He discussed the need for perfected instruments such as high-speed, auto-recording balances and instruments for recording refractive index and for photoelectric titration.

Dr. L. H. Lampitt, chief chemist of J. Lyons and Co., Ltd., Laboratories, London, gave the third Congress lecture, with the title "The Value and Economic Importance of Chemical Analysis in Industry and Manufacture". He traced developments from the chemical revolution of the seventeenth century to the present time, and pointed out that to-day the analyst is in a position to aid industry in the main fields of commercial activities, namely, research, process development and process control. He stressed how, in industry, analytical control could, by means of instrumentation, be carried out by relatively unqualified (in the academic sense) persons, and their work could be assessed as a 'bench-rate', a prime charge against the article manufactured.

Finally, Prof. van Nieuwenburg, professor of chemistry in the Technical University of Delft, spoke on "A Contemporary Assessment of the Place of Classical Methods in Chemical Analysis". He spoke of the revolutionary changes in chemical analysis and of the fact that most of the papers read at the Congress were on matters or techniques unheard of twenty-five years ago. The classical methods, which are essentially chemical, may be losing ground, but they still have a future, as the new physical methods need them as a basis.

The papers read at the Congress and the discussions that followed are to be published in the November and December numbers of *The Analyst*, and the whole of the proceedings will be available as a separate bound volume for members of the Congress and others. Consequently, the papers are not here reviewed in detail, but a brief survey is given of the general and specialized subjects discussed.

Five papers on microchemical methods were read, that on the direct micro-determination of oxygen in organic substances being particularly interesting. The apparatus involved was shown at the apparatus exhibition. The micro-gravimetric determination of lead as sulphate and of silver and of mercurous mercury as chlorides was described; the determination of fluorine by the lead chlorofluoride method in compounds containing halogens, sulphur, phosphorus and arsenic was reviewed; and other papers included a description of a counter-current micro-rotary extractor and a summary of some of the approaches that have been utilized in the development of spot tests, using either organic or inorganic reagents.

In the subject group of optical methods of analysis, there were six papers, covering two sessions. These papers served to illustrate the greater value of 'open' subjects when they are intended for general discussion at meetings. For example, an account of recent advances in infra-red spectroscopic techniques and a paper on the colorimetry of indicators both aroused keen discussion. On the other hand, the papers on ultra-violet absorptiometric determination of arsenic as 12-molybdoarsenic acid (designed for large percentages of arsenic) and on ultra-violet absorption spectra of pyridoxine and related compounds were only of interest to a limited number of people, although valuable in print. In addition, the application of emission spectrography to the routine determination of metals soluble in lubricating oils

and the identification by X-ray diffraction of crystalline inclusions in glass were discussed.

The session on the presentation of data moved briskly under a forceful chairmanship. Two papers which were taken together and which aroused considerable interest were those on statistical aspects of analytical determinations, for the detection and correction of sources of error in analytical procedures, and on statistical design in the study of analytical methods, to determine the sensitivity of an analytical method. The third paper in this subject group was on statistical methods in radiochemistry.

The morning of September 6 was devoted entirely to the study of radiochemical methods, and this naturally attracted the chemists working in the newer fields of atomic research. A paper on the determination of trace quantities of the alkali metals by neutron activation analysis claimed that this type of analysis is unique because of its great sensitivity and the fact that other elements do not interfere. Two papers were read on the determination of small quantities of uranium by radioactivation and on precision counting of α-particles, while the preparation of astatine by bombardment of bismuth oxide with helium ions and the solvent extraction of Group III*B* metal halides with the aid of radionuclides were also discussed.

The session on organic complexes opened with a paper on some factors controlling the selectivity of organic reagents, in which a product ML_n, formed from a cation M and an acidic reagent HL, if it has suitable physical properties, may serve as a basis for a test for M. The stability of metal 'chelates' in relation to their use in analysis, and 1 : 10-phenanthroline and mono-, di-, tri- and tetra-methyl-1 : 10-phenanthrolines as chelated copper complex cations were studied; also discussions took place on the complexes formed by thorium and uranyl ions with complexones (that is, derivatives of iminodiacetic acid) and on the fractionation of ozokerites and the separation of optical isomers.

A general survey on a fundamental approach to the establishment of *p*H standards opened the session on electrical methods. It was emphasized that *p*H can never possess the absolute significance of a true thermodynamic constant. A method of determining the equivalence point in potentiometric titrations, applicable to instruments calibrated either in millivolts or *p*H units, was said to have been achieved by a numerical manipulation transforming potential-volume curves into straight lines intersecting at the equivalence point. Also included were papers on the replacement of the standard cell and salt bridge by indicator electrodes and the use of non-aqueous solutions in potentiometry, on square-wave polarography, and on polarography of the tetrathionate ion.

It was perhaps significant that nine papers were presented to the adsorption and partition methods group, involving three separate sessions of the Congress. Recent work on gas chromatography was illustrated by the separation and analysis of volatile organic mixtures by displacement chromatography from charcoal columns at 100° C. to an accuracy of better than 1 per cent. It was also suggested that some of the limitations of current chromatographic procedures are overcome by gradient elution analysis, although it has certain disadvantages. The theory of the partition column has been extended to include a compressible mobile phase of a permanent gas, and a method of determining the height equivalent to a theoretical plate of such a partition column has been given. The apparatus involved was demonstrated at the apparatus exhibition.

The theoretical aspects of paper chromatography have been studied with the aid of semi-automatic instruments based on the square-law behaviour of the ascent or descent of liquid in a strip or sheet of paper. In the field of quantitative inorganic paper chromatography, working details were given for a new chromatographic separation of aluminium, titanium and iron in three individual spots within a time of 330 min. and an accuracy of ± 2 per cent. The separation of individual groups of water-soluble extracts of plant and animal tissues was achieved by displacement chromatography on ion-exchange resins, a technique that led to the chemical characterization of new or unexpected components.

Other papers included one on the use of electrokinetic ultrafiltration to enable the larger molecules of the polysaccharides to enter the porous materials used for chromatography, the inability to do so being normally a serious difficulty, one paper on the applications of ion exchange to analytical chemistry, and one on the quantitative determination of tantalum and niobium by inorganic chromatography on cellulose. This last technique was demonstrated at the apparatus exhibition.

The less-exact science of biological methods attracted more limited audiences. Papers in this subject group included those on the use of protozoa in analysis; the use of fungi for determining trace metals in biological materials, whereby increased growth in test fungi was stimulated by the addition of graded amounts of certain metals, from deficiency to sufficiency levels, to a culture solution containing all the other essential nutrients; and the quantitative assay of pyrogens by the febrile response in rabbits, using selected animals according to their body temperature, body weight, sensitivity, excitation and tolerance.

In the session devoted to general subjects a titrimetric method was described for the rapid analysis of certain binary liquid mixtures to which alternative methods may not be readily applicable, and the quantitative determination of organic halides by evaluation of reaction velocity curves was discussed.

The exhibition of analytical techniques and apparatus, so efficiently organized by Mr. F. R. Jones, was regarded by some as the most important feature of the Congress. Sir Robert Robinson, in expressing the wish that the exhibits could be retained for his students to see, echoed the thoughts of many visitors who felt that it was a minor tragedy to have to dismantle these outstanding exhibits, involving as they did a wide range of subjects and craftsmanship and ingenuity of design of a high order. The usefulness of the exhibition was enhanced by the fact that it was staffed at all hours by an enthusiastic team of demonstrators who were qualified scientific workers, specialized in their particular subjects and always ready to answer questions or to discuss the fundamentals of their exhibits.

It must be clearly understood that selection of the items for description in this article has been quite arbitrary and that only lack of space precludes the inclusion of them all. Some, it is understood, have been, or are to be, published in the *Journal of Scientific Instruments*.

In the case of three of the scientific papers described above, reference was made to the fact that the instruments or techniques involved were also demon-

strated at the exhibition. These included: an apparatus for the determination of oxygen in organic compounds, in which the products of pyrolysis of the compound are passed in a stream of oxygen-free nitrogen over carbon at 1,120° C., the carbon monoxide produced being oxidized by iodine pentoxide at 120° C. and the liberated iodine oxidized to iodate and determined by thiosulphate; the use of partition chromatography involving a mobile gas phase and a stationary liquid phase to separate and estimate micro-amounts of volatile fatty acids from formic acid to lauric acid, including all the isomers of valeric acid; and the application of paper strip technique, widely used in organic separations, to inorganic materials covering a very wide range, and the application of the method to separations on a larger scale using columns of cellulose powder.

A popular exhibit was that demonstrating remote-handling devices for radioactive work. It comprised a 'gamma handling cell' for the safe handling of 100 mC. of 1-MeV. gamma-ray sources, tongs for changing tong-heads remotely and a mechanical simulator which is a model of a machine used for accurate manipulation from behind a dense shielding-wall—for example, 2–3 ft. of concrete. An excellent instrument was shown, known as the 'thermistor ebullioscope'. This instrument is intended for the rapid and precise routine determinations of molecular weight. Rapidity is achieved by employing thermistors as short time-constant differential thermometers, and precision by the use of specially designed vapour-jacketed ebullioscopes. Boiling-point elevations, accurate to 0·0005 deg. or less, can be read within about two minutes of adding the solute.

A large and beautifully laid-out exhibition of microchemical apparatus had been organized by the Norwood Technical College (London County Council). This exhibit aroused considerable interest, and the demonstrators were tireless in answering questions. Most of the items were of very simple construction, but the success of the exhibit lay in the fact that the large number of pieces of micro-glassware—methods of stirring in small-scale work, micro-conductometric and other electrochemical techniques and apparatus for small-scale organic syntheses and identification and for general microchemistry—had been made and assembled by a team of enthusiasts working in their spare time.

A fascinating demonstration of new methods of microscopy was organized by Dr. R. Barer, of the Department of Anatomy, Oxford. The subject was, of course, highly specialized, but was of considerable interest to all the visitors who saw the demonstration. There were also demonstrations of a new method of identifying crystalline substances by measurement of interfacial angles, and of the Federov universal stage for determining the optical constants of crystals.

Altogether there were eighty-seven exhibits provided by forty-one individuals, firms, laboratories, research associations or colleges. There was also a trade exhibition of instruments, apparatus and books, effectively organized by Mr. W. Thompson, in which forty-four trade exhibitors were represented.

Apart from the purely scientific side of the Congress, the social side was catered for in a simple but effective manner by the arrangement of tours and excursions. Several informal receptions took place, and a banquet was held in the Hall of Christ Church. The Congress was undoubtedly a great success, and the next one will be awaited with pleasurable anticipation.

ELECTRICAL DISCHARGES IN GASES

AT the recent Belfast meeting of the British Association, a session was held on September 8 by Section A (Mathematics and Physics) which was devoted to electrical discharges in gases. The rather full programme included six papers on important aspects of this subject and a discussion. Prof. A. M. Tyndall presided.

The application of the subject of electrical discharges to-day covers a wide range in physics, including, for example, the investigation of certain properties of matter; the nature of ion–atom reactions; metal surface phenomena in discharge tubes, Geiger counters, and electrical contact devices of every kind; radar switches and the generation of radio-frequency oscillations; high-voltage insulation by compressed gases; and ion sources for nuclear physics. The strong interest was reflected in the full attendance, which included a number of electrical engineers.

The session was opened with a paper by Prof. F. Llewellyn Jones (University College, Swansea) on the electrical breakdown of gases. Discharge phenomena at low pressures, at atmospheric pressures, in highly compressed gases and at electrical contacts appear very different, and different theories have been proposed. Recent work, however, suggests that there are basic principles common to all these aspects. Breakdown at low pressures has been shown to be controlled by primary ionization with a secondary process determined by the nature and geometry of the cathode. For sparks at atmospheric pressure an entirely different theory depending on space-charge effects has been proposed, but recent precision measurements of the ionization currents just prior to sparking show that breakdown in uniform fields at this pressure also is controlled by primary and secondary ionization processes the relative importance of which is controlled by the nature of the cathode[1]. No space-charge effects have been found. With high voltages and compressed gases breakdown appears to be different again in that Paschen's law fails, but this can be explained by the additional generation of electrons by field emission from the cathode. Similar effects can occur at electrical contacts[2]. On the generalized theory proposed, breakdown is a consequence of the development of ionization currents in the gas by primary and secondary processes. No single secondary process always predominates; several can and do occur, sometimes together, sometimes singly. The factors which mainly determine the predominant process in any particular case of breakdown are the nature and geometry of the cathode. In this respect, therefore, the physics of electrical breakdown of gases has much in common with the physics of surfaces.

Dr. C. Grey Morgan (University College, Swansea) described an investigation of cold-electron emission both from electrodes covered with thick oxide layers and from those with thin tarnish films. With heavily oxidized metals, of the type often encountered in heavy electrical engineering, emission of 10^5 electrons/sec. was obtained with low electric fields of about 10^5 V./cm. The fundamental physical process underlying this emission is considered to be the extraction of electrons from ionic sites on the thick contaminating oxide layers always present on surfaces operated in the atmosphere[1]. Another class of

surfaces, of great interest in applied and theoretical physics, was also investigated; these were surfaces covered with thin tarnish films of but a few atoms thick. Again, unexpectedly high electron currents were obtained at the low electric fields of 10^4 V./cm., but investigation of the mechanism of this emission showed it to differ from that for thick films. While the mechanism was still a cold field extraction process, it is thought that the electrons actually came from the underlying metal by extraction in an intense surface field set up by the positive ions lying on the surface tarnish film. This effect can lead to a considerable enhancement of the Townsend secondary coefficient. This work directs attention to the important part played by the electrode surfaces in initiating spark breakdown.

Experiments designed to investigate the ionic constituents in gaseous discharges were described by Dr. R. L. F. Boyd (University College, London). The use of the magnetic mass-spectrograph as a probe is impracticable in this work because of difficulties of obtaining radial movement of the probe, screening the discharge from the magnetic field, and collimation of the beam of particles. A new small radio-frequency mass-spectrometer probe which avoids these difficulties was described. This employs a time-of-flight method of discrimination between ions of different mass/charge ratio. With this instrument measurements of the radial variation of negative ion density was measured in oxygen, where the negative oxygen ion concentration is only a hundredth of that in the halogens at the same electron concentration, although the probability of attachment of electrons to iodine atoms and to oxygen is about the same. Preliminary evidence indicates that associative detachment is the most likely process able to account for the sufficiently fast removal of negative ions in oxygen.

Prof. K. G. Emeléus (Queen's University, Belfast) described experiments on the generation of plasma electron oscillations by a hot-cathode discharge. The oscillations ($5 \text{ cm.} < \lambda < 200 \text{ cm.}$) were picked up by a small probe projecting into the glow in the region near the filament. The frequency f of the oscillations was of the same order as that calculated on the assumption of electrostatically controlled vibrations of an electron cloud displaced from an equilibrium position in the discharge plasma, and is given by the Tonks–Langmuir relation

$$f = (Ne^2/\pi m)^{1/2},$$

where N is the number of electrons per c.c., and e and m the electronic charge and mass. With directly heated cathodes oscillations are detected at discharge currents below saturation values. Both with directly and indirectly heated cathodes, the oscillations appeared to be produced over a wide range of tube characteristics. The experimental observations of Merrill and Webb showed that the oscillations were confined to narrow layers of glowing gas near the filament; the primary electrons passing through these sheets were subjected to velocity modulations. These conclusions were confirmed by Prof. Emeléus and his co-workers. Experimental observations support the view that both a primary beam of electrons and a discharge plasma are essential for the generation of oscillations. It is suggested that the complicated motions of the ions and electrons in discharge tubes set up, for example, by the influence of the magnetic field due to the drift current, are analogous to hydrodynamical turbulent flow in fluids. The apparatus used in this work was described by Prof. Emeléus: the discharge tubes could be made easily demountable, as the results were not affected appreciably by impurities in the gas.

Present knowledge of the physical processes which initiate and maintain high-frequency discharges was outlined by Dr. A. H. von Engel (University of Oxford). Experiments covering a wide range of frequencies and pressures were described. At ultra-high frequencies ($\sim 3 \times 10^9$ c./s.) the work of Mac-Donald and Brown on the limits of the application of the diffusion theory of electron loss and the work of Prowse at atmospheric pressure were outlined. The case where the mean free paths of the electrons are much less than the dimensions of the tubes or electrode separations was next considered: Llewellyn Jones and his collaborators have established a general similarity theorem involving the oscillation frequency as well as the linear dimension of the discharge tube. The work of Gill and von Engel and of von Engel and Francis on the growth of the discharge was then described. The mean free paths of the electrons in these experiments were greater than the dimensions of the discharge tubes, and the field required to initiate the discharge was dependent on the nature of the end walls of the tube on which the electrons impinged. The growth of the electrodeless discharge was shown to depend both on the production of a space charge which reduced the amplitude of oscillation of the electrons until it was less than the length of the discharge tube, and on the establishment of an equilibrium state in which the generation of ions and electrons in the gas equalled the losses to the walls[1,2].

Mr. C. E. R. Bruce (British Electrical and Allied Industries Research Association) considered the case of discharges on both the largest terrestrial and on the cosmical scale; a certain resemblance between photographs of the largest laboratory spark, the lightning flash and solar flares has been found. In discussing the lightning flash, it was pointed out that the earlier recombination theory of the so-called leader stroke is incompatible with the large currents of the order of 1,000 amp. deduced both from magnetic field changes produced by the upward leader strokes from the Empire State Building, New York, and also from changes in the electric field observed to accompany propagation of normal downward leader strokes from the cloud. It was suggested that the leader stroke column has arc characteristics, and that there is a high radial loss of ions from this column by corona loss; the steps by which the leader stroke progressed may represent corona-to-arc transitions. Such a transition may represent the criterion of instability determining the breakdown of very long gaps.

An interesting discussion followed occupying all the time available. Prof. Emeléus discussed certain anomalous inductance and capacitance effects in neon discharge tubes. Mr. S. C. Haydon (Swansea) considered the case of photo-ionization of the gas as a possible secondary ionization mechanism in the breakdown process. He gave the results of calculations on the growth of pre-breakdown ionization currents when photo-ionization was taken as the predominant secondary ionization process. These showed that photo-ionization did not account for the observed growth of currents in air.

Prof. Tyndall raised the question of the possible micro-distortion of the electrode surface due to the

sparks used in the experiments on the cold electron emission from surfaces, and pointed out that appreciable disturbance of the surface geometry can enhance the local electric field by producing sharp points. In reply, it was stated that the current in these measuring sparks is severely limited, and experiment shows that no significant distortion of the surface and field enhancement occurs throughout the whole period of measurement. Dr. J. Dutton (University College, Swansea) discussed the significance of the formative time-lag of breakdown, and pointed out that the magnitude of the formative lag depends on the particular Townsend secondary ionization process which is predominant in the generalized theory of breakdown here put forward. Assuming cathode electron emission due either to incidence of photons alone, or with positive ions, calculations showed that in both cases a rapid fall of formative lag from 10^{-4} sec. to 10^{-6} sec. is to be expected as the overvoltage increases from 0 to 2 per cent, although the shape of the two curves differs significantly in detail.

Dr. Boyd discussed further the case of recombination in helium and also gave a fuller account of the radio-frequency mass-spectrometer probe. The high recombination observed in a decaying radio-frequency discharge can be accounted for by the process, proposed by Prof. D. R. Bates (Queen's University, Belfast), of dissociative recombination involving a preponderance of molecular helium ions. This view has been confirmed by measurements with the radio-frequency probe. The reaction involving metastable atoms of helium with a hydrogen molecule was discussed in some detail by Prof. Bates and Dr. Boyd.

F. Llewellyn Jones

[1] *Nature*, **168**, 140 (1951).
[2] *Nature*, **169**, 960 (1952).
[3] *Nature*, **169**, 317 (1952).

CHEMISTRY AND FOOD PROCESSING

A DISCUSSION on food processing, arranged by Section B (Chemistry) of the British Association, took place on September 8 during the Belfast meeting. The food processing industry is steadily developing in Northern Ireland, and Prof. W. Wardlaw's presidential address to the Section, on "The Advancing Front of Chemistry", had dealt *inter alia* with some recent aspects of this industry.

The chair was taken by Prof. H. D. Kay (Shinfield), who gave an introductory paper. He pointed out that a very large proportion of what modern civilized man eats (and much of what he drinks, including many town and country water-supplies) is processed, with the object either of increasing keeping quality, thus permitting the conservation or the long-distance transport of perishable foods, or of rendering the raw food more palatable or digestible or of removing danger of disease. Typical examples were given of foods in each category.

Better food processing would enable the very considerable loss—possibly 15 per cent or more—of human food between production and consumption to be markedly reduced, a matter of real significance in a world where food supplies are increasing less rapidly than populations. Further, many human inhabitants of the world to-day are more-or-less severely parasitized, and efficient food processing would reduce food-conveyed infestation and thus improve general health and working capacity.

The addition to food of chemical substances such as colouring, flavouring and preservative agents and 'improvers' is now under good control in the United Kingdom, and, continued Prof. Kay, there is little evidence that any of those which are at present permitted are dangerous to human health. In fact, some of these additions, like that of vitamins A and D to margarine, are nutritionally beneficial.

In the category of food processing come also the manufacture of new foods, not previously eaten, for human or animal consumption. An example is the production of acceptable human foods from the world's most important crop—grass—and another is the production of palatable, protein-rich food for man and for farm animals by growing yeasts and other organisms on waste carbohydrate (of which a great deal is available) in the presence of inorganic sources of nitrogen and phosphate. Circumstances in the near future will probably compel the active prosecution of further research on such problems.

Prof. Kay also mentioned the development in the United Kingdom of improved methods for the processing of home-produced feed for the winter keep of farm animals. He discussed modern ensilage technique and gave the results of some recent experiments at the National Institute for Research in Dairying, Shinfield, in which different methods for making silage from young herbage crops were compared.

A valuable summary of the science underlying modern bread-making was given by Dr. A. J. Amos (London). He described the biochemical processes involved in the steady production, from the starch of the wheat, of the sugar necessary for gas formation by the yeast incorporated in the dough. Sugar production, which usually requires several hours, depends in part on the quality of the original wheat and in part on the damage caused to the starch granules during milling. The addition of enzymes derived from cultures of *Aspergillus oryzæ* is a recent development, now used commercially in the United States, for the correction of low diastatic activity in flour. Slides were shown illustrating the rather complex relationship between the amount of yeast present and the rate of gas production.

In addition to an ample supply of sugar for the yeast, and the satisfactory conversion of this into carbon dioxide, the physical nature of the flour proteins when made into dough must be suitable. Bread made from fresh-milled flour is quite unacceptable; the flour has to be 'aged' for some weeks, during which time changes due to the action of atmospheric oxygen take place, before it is fit for commercial use. In the ageing process the flour also becomes whiter owing to the oxidation of the yellow colouring matter—mainly xanthophyll.

Though beneficial and indeed commercially necessary, the natural ageing of flour is a process which demands the storage under appropriate conditions of several weeks supply of flour. It has been found that the addition to the fresh flour of minute amounts of ammonium persulphate rapidly brings about 'ageing'. Other oxidizing agents have also been discovered which 'improve' the flour by ageing it artificially. The beneficial effect of improvers is due largely to their direct action on the protein. The protein is present in the form of a three-dimensional network with cross-links between neighbouring molecules. 'Improvers' increase the number of such cross-links,

probably by oxidizing contiguous sulphydryl groups on adjacent protein molecules to form new disulphide bonds.

A recent discovery which is the basis of a patent is that the improving and bleaching effects, obtained in several weeks by natural ageing, can be brought about in a matter of minutes by distributing atmospheric oxygen, applied by means of a special high-speed mixer, through a batter made from the wheat flour, in presence of a source of oxidases such as soya flour.

Dr. Amos discussed whether the addition of chemical improvers to flour has any harmful effect either on the nutritional value of the bread or directly on the consumer. There is no significant effect on the vitamins of the B complex, and though flour treated with nitrogen trichloride has been shown to cause hysteria in some dogs, there is no evidence whatever that it harms human beings. Nevertheless, because it could be detrimental to some animals, it is probably unreasonable to quarrel with the decision to discontinue its use. The other oxidizing substances used as flour improvers or bleachers have been thoroughly tested in both animals and man, at a level much higher than that in which they are added to bread (one part in 7,000–65,000 of bread) without any ill effects.

Dr. J. A. Lovern (Torry Research Station, Aberdeen) discussed some modern advances in fish processing. Our knowledge of the chemical composition of fish and the changes which occur in fish tissue subsequent to catching has steadily increased, and we now have a rational background for the introduction of improved methods of storage and processing. There is little doubt that any direct use of new chemicals for the preservation or processing of fish would conflict with existing food and drugs regulations.

It is to be remembered that the greater part of the catch obtained by the British fishing industry is in distant grounds—up to five or more days steaming from the home ports. This period, added to the week or so spent in actual fishing, means that much of the catch has to spend two weeks or more in ice before it reaches the consumer. The ice itself is at times made from water containing antiseptics such as hypochlorite, hydrogen peroxide, etc.; one of the most promising bacteriostatic agents is a high concentration of carbon dioxide in the fish-room atmosphere.

There are three broad phases in the course of changes in fish after stowing in ice: first, the period until the fish passes out of *rigor mortis*, during which no bacterial invasion takes place; second, bacterial multiplication and the conversion of trimethylamine oxide (originally present in the fish, but having no odour) into the strong-smelling trimethylamine; third, the progressive breakdown of fish protein, under the attack of bacteria, with the production of ammonia, indole, etc. For practical purposes the second stage is the important one.

While efficient freezing and cold storage of fish completely stop bacterial attack, other types of spoilage can occur, for example, autolysis and atmospheric oxidation. Cytochrome *c* and other respiratory pigments of the muscle have been found powerfully to catalyse the oxidation of fat in cold-stored fish. This oxidation is most effectively controlled by excluding air from the system, for example, by means of a coating of ice, with or without the addition of anti-oxidants.

The process of fish smoking was also discussed by Dr. Lovern. He said that the constituents of wood smoke, as produced in the usual smouldering fire, are not the same as those resulting from the destructive distillation of wood, since the primary distillation products are extensively hydrolysed in passing through the zone of hot damp wood above the smouldering area. The smoke is rich in polyphenols, presumably derived from the lignin fraction of the wood, which are deposited on the fish. When smoked fish is kept for some time, it is not until the concentration of phenols on the fish begin rapidly to decrease that microbiological attack on the damp fish begins. Present research is being directed to a study of the effective smoke constituents, as deposited on the fish, in relation to microbiological spoilage.

The last of the main contributions to the symposium was that of Mr. P. N. Williams (Unilever, Ltd.) on the processing of fats. He reminded the audience that most of the butter and lard consumed in the United Kingdom is produced overseas, so that the main oils and fats processed in Britain are of vegetable or marine origin. Much of the crude oil reaching the United Kingdom for processing (except the whale oil) is of poor quality.

It seems certain that, if the diet of the increasing population of the world is not to have a diminishing fat content, vegetable oils will have to be produced and processed in increasing quantities. At present, most of the crude vegetable and marine oils imported into Great Britain are first refined to edible quality and then further processed into margarine, or into 100 per cent fat products such as 'shortening' (cooking fat) or 'compound lard'.

In refining crude oils, impurities are removed by neutralization, bleaching and deodorizing. Free fatty-acid is removed by the first of these processes, which consists in the addition of alkali—usually fairly strong caustic soda—removal of the soaps so formed and washing with water. Bleaching is usually achieved by shaking under reduced pressure with activated fuller's earth, and deodorization by passing steam through the oil, also at reduced pressure. Subsequent hydrogenation of the oils, to produce end-products with the requisite physical properties, is brought about commercially by passing hydrogen through the warm oil in the presence of carefully prepared nickel carbonate-plus-hydroxide catalyst. If the oils are highly unsaturated, the heat of reaction with hydrogen is such as to require cooling water to be passed in through coils in the cylindrical hydrogenation vessel.

To prepare margarine, a mixture of the hard hydrogenated fats with liquid oil and separated milk (which has been soured under controlled conditions to produce a desirable flavour) is churned. The resulting emulsion is cooled on a rotating drum, and the cooled flakes obtained are afterwards worked to obtain the requisite rheological properties. An alternative modern method, which has the advantage of being continuous, employs an improved form of the 'rotator'—a refrigerated, stainless-steel cylinder, equipped with an agitating system, into which the fat–milk mixture is poured. After shaking, the semi-solid fat is extruded direct to automatic packers.

At a stage before the final churning, vitamin A in the form of a concentrate prepared from whale liver oil, and crystalline vitamin D, are added to the fat. Since a large part of the margarine sold in the United

Kingdom is coloured by the addition of the natural pigment and vitamin A precursor carotene, further vitamin A is produced in the intestine. The nutritional value of such margarine is at least equal to that of butter, and is constant throughout the year. Mr. Williams's paper, like that of the other speakers in the symposium, was illustrated by lantern slides.

In the subsequent discussion, Mr. F. C. Cooke (Ceylon) stated that if the United Kingdom is to secure a steady supply of vegetable fats from overseas for processing, an economic agreement is urgently required which would give some assurance as to future prices to producers of such fats. Another speaker said that, with the advance in the quality of processed vegetable fats and the steadily rising cost of butter, the future of the latter is becoming highly insecure. While there would doubtless be an increasing trend towards the consumption of liquid milk, of dried whole milk and of cheese, butter can scarcely escape the fate of becoming little more than a luxury product.

OBITUARIES

Prof. F. T. Hill

FREDERICK THOMAS HILL, assistant professor of aeronautics in the Imperial College of Science and Technology, London, died on September 24 within a few days of his retirement.

Prof. Hill was born on November 13, 1886. He was apprenticed to the Great Eastern Railway Company and completed his education at Queen Mary College, London. He then worked on engineering design with the Whitehead Torpedo Co., until he joined the City and Guilds College, Finsbury, as an instructor in 1911. He developed an interest in aeronautics and became the first teacher of that subject in a British institution. During the First World War he joined the Royal Flying Corps as a designer and reached the rank of captain.

He joined the newly formed Department of Aeronautics at the Imperial College of Science and Technology as a lecturer in 1920, and he became assistant professor with special responsibility for design in 1924. For twenty-five years this was the only entirely postgraduate department of aeronautics in Great Britain. It was dominated by Hill and Sir Leonard Bairstow, head of the Department. Few of the senior technical people in the British aeronautical world have not passed through their hands, and many will have had their first experience of wind tunnels in the Imperial College 'channel' designed by F. T. Hill. In later years he fought a losing battle for the recognition of design as a postgraduate university subject. However, the more recent generations of students must have benefited from his documented accounts of earlier mistakes.

His particular interest was in the materials of aircraft construction, and the many editions of his book on that subject have become a classic since it first appeared in 1933. He was working on a new edition at the time of his death.

Hill's life was devoted to his work, and this left time for little else. However, he was a founder member of the Institution of Aeronautical Engineers, a Fellow and sometime Member of Council of the Royal Aeronautical Society and a member of many committees of the University of London and of his College. He is survived by his wife, a son and a daughter.

P. T. FINK

WE regret to announce the following deaths

Dr. W. T. Calman, C.B., F.R.S., lately keeper of zoology, British Museum (Natural History), on September 29, aged eighty.

Dr. Philipp Ellinger, formerly of the Lister Institute, on September 12.

Prof. F. C. Lea, O.B.E., emeritus professor of engineering in the University of Sheffield, on September 30, aged eighty-one.

NEWS and VIEWS

Surgery in the University of Otago : Prof. M. Woodruff

MR. MICHAEL WOODRUFF, senior lecturer in surgery in the University of Aberdeen, has been appointed Ralph Barnett professor of surgery in the University of Otago, New Zealand. Mr. Woodruff, who is the elder son of Prof. H. A. Woodruff, formerly professor of bacteriology in the University of Melbourne, was born in Britain but educated in Australia, where he graduated at Melbourne in both electrical engineering and medicine. During the Second World War he served in Malaya with the 10th Australian General Hospital, his experimental work on deficiency diets during the captivity at Changi Camp having been the subject of a recent publication by the Medical Research Council. In 1946 Mr. Woodruff was appointed tutor in surgery and lecturer in surgery to dental students at the University of Sheffield, but went to his present post in Aberdeen two years later. He will take up duty in Dunedin early in 1953.

European Cortina-Ulisse Prize : Prof. E. H. F. Baldwin

THE European Cortina-Ulisse Prize of a million lire (about £600) has been awarded to Prof. E. H. F. Baldwin, professor of biochemistry in University College, London, for his book "Dynamic Aspects of Biochemistry". This Prize is promoted by the cultural magazine *Ulisse* for the best publication, produced in Europe during the past five years and written in a European language, dealing with an assigned topic (not necessarily scientific). When the Prize was first instituted in 1949, the set subject was the popular exposition of physics or chemistry, and the winner was Prof. John Read, professor of chemistry in the University of St. Andrews. The topic for 1952 was that of biochemistry considered exclusively in its relation to the human organism and with special emphasis on its application to medicine.

International Laboratories in Latin America

A GROUP of scientific workers recently met in Montevideo under the auspices of the Unesco Science Co-operation Office for Latin America in order to study the possibility of establishing international and regional laboratories in Latin America. The meeting stressed the importance of the special conditions existing in Latin America (geographical situation, flora, fauna, etc.) for research work of international interest, and there was complete agreement that such

work could best be done by the common effort of the countries concerned through the medium of the Science Co-operation Office. It was decided that the most urgent need was to create a net-work of laboratories of marine biology. Secondly, a certain number of 'service laboratories' should be organized on a regional scale, in the first place by giving some laboratories now operating on a limited national scale the facilities for extending their services to the whole region; the laboratories so selected are to be those dealing with chemical analysis, conservation of microbiological type-cultures, X-ray analysis and scientific films. Finally, the meeting recommended that an Inter-American Institute for Cosmic Ray Research should be set up, with the task of establishing a net-work of cosmic-ray research stations at appropriate altitudes and latitudes, taking into account the stations already in existence; the Institute would have the responsibility of standardizing the equipment and co-ordinating and facilitating the research work in these stations. Those attending the meeting were: Profs. M. O. de Almeida (Brazil), V. Deulofeu (Argentina), I. Escobar (Bolivia), C. Estable (Uruguay), A. G. Domínguez (Argentina), J. Ibañez (Chile), C. Lattes (Brazil), M. S. Vallarta (Mexico), R. Tálice (Uruguay) and F. De Venanzi (Venezuela).

Science for Peace: Statement on the British Atom Bomb

The National Committee of Science for Peace, 49 Flower Lane, London, N.W.7, has issued the following statement: "The recent announcement that an atomic bomb has been made in Britain has been welcomed in some quarters as an illustration of British scientific and technical skill. As an organization of practising scientists, we feel that it serves rather to provide yet another instance of wasteful and dangerous misdirection of scientific effort. . . . To those who argue the priority of defence, we have an obligation, as students of the technical possibilities of modern warfare, to point to the fact that Britain is the most vulnerable of all the great powers to atomic attack. By permitting the installation of N.A.T.O. atomic bases in this country, successive governments have ensured that in the event of war Britain will become the target for a type of offensive to which we are satisfied there can be no practical defensive answer. . . . We call on our government to abandon the path of the atomic arms race. . . . The only practical defence of Britain to-day lies in a programme, to be undertaken by men who have the moral courage to dissociate themselves from indiscriminate massacre as a military policy, with a twofold aim: the use of scientific resources for the development of our own economy and the raising of world living standards, and the sincere and tireless pursuit of conciliation. This organization has never advocated the unilateral surrender of a legitimate defensive weapon. At the present time, the measure of agreement already reached between the powers is, in our opinion, adequate to enable international renunciation of atomic warfare to be achieved without delay, on a basis of reasonable compromise".

European Seismological Commission: Meeting in Stuttgart

During the week September 21–27 the first meetings of the European Seismological Commission, as constituted by the International Union of Geodesy and Geophysics at Brussels in 1951, took place in Stuttgart. The meetings were attended by representatives from twelve European countries, three being from Great Britain. Seismologists from Algeria and South Africa also attended. The main subjects discussed were the seismicity of the European continent, the structure of Europe, the thicknesses of the continental layers as determined by elastic waves set up by explosions, earthquakes and gravity anomalies, near earthquakes in Europe, the motion at the focus of an earthquake and the determination of the depth of focus, seismological observatory work in various European countries, seismogram interpretation including graphical methods, and wave theory. The meeting, the arrangements for which were in the hands of Prof. W. Hiller, was eminently successful, and it is intended to issue a report in due course.

Mathematical Research Institute of Oberwolfach

The Mathematical Research Institute of Oberwolfach (State of Baden), in the French Zone of Germany, has been functioning regularly since it was first opened in 1945 under its honorary director, Prof. W. Süss, of Freiburg (editor of the German Fiat reviews in mathematics), and a large number of informal conferences have been held there, the most recent being one at the end of September on algebra and number theory. All grades and ages, from newly graduated research students to professors of world renown, from inside and outside Germany, are represented in the visitors' book, and the atmosphere of stimulating homeliness, friendliness and freedom to which all testify is due to the quiet management and personalities of the hosts, Prof. and Mrs. Süss. The Institute is attached to the University of Freiburg and receives a small annual government grant for running expenses and equipment. It welcomes all working mathematicians (and their families, as far as space permits) and offers them, at a minimum charge to cover the cost of food, an excellent library, facilities and leisure for relaxation or work, in a comfortable modern country house which is the gift of the State of Baden. It is open all the year round; but, owing to the prohibitive cost of central heating, only a few rooms are in use during the winter. In summer-time, the typical Schwarzwald scenery makes it very attractive, and many of the meetings are held in the open. Proposals for future work are gladly received. Following a suggestion by Prof. Martin Eichler, of Münster, the ideas of Hecke and his school in the field of automorphic functions, algebraic functions and analytical number theory are to be discussed, probably during the second half of this month.

Museum of Leathercraft, London

Considering the great importance of leather in the past and its not inconsiderable value at the present time, it is strange that only recently has there been established a museum devoted to its study and its relation to the development of civilization. The Museum of Leathercraft has now been founded, and is housed in temporary quarters in the National Leathersellers College, Tower Bridge Road, London, S.E.1. Although the formation of a collection is its main purpose, the scope is much wider. Its aims have been set out in the following terms: "The establishment of as complete a historical record as possible of the preparation and use of leather, in all ages and in all countries, by the acquisition of actual examples

and of documents, prints and books. The undertaking and encouragement of research into all historical aspects of the subject. The stimulation of research into the best ways of using leather, into possible new uses and into the production of new and special types of leather. The preservation and encouragement of high standards of craftsmanship and design". During the preparatory period, the Museum staged a comprehensive exhibition entitled "Leathercraft through the Ages", planned by Dr. C. H. Spiers and Mr. J. W. Waterer and shown at many provincial centres as well as in London.

Brotherton Collection of the University of Leeds: Annual Report for 1950–51

THE sixteenth annual report of the Brotherton Collection Committee of the University of Leeds covers the session 1950–51 (pp. 9; University, 1951) and records the virtual completion of the cataloguing of those books in the English literature section which had not been incorporated in the new catalogue. A start has been made on cataloguing the Romany Collection. On June 30, 1951, the Brotherton Collection contained some 23,726 books, 15,927 pamphlets, 585 manuscripts, 4,106 deeds, 31,555 letters and 25 maps. The first main exhibition of the session consisted of books, manuscripts and other items from the Romany Collection presented earlier in the year by Mrs. McGrigor Phillips. The second exhibition, of English grammars and dictionaries, designed to illustrate their development from the seventeenth to the nineteenth centuries, drew upon the resources of the whole University library, and a third exhibition of books and other documents of 1851 was planned to illustrate the life, thought and literature of a century ago. Some thirty organized parties were included among the yearly total of more than a thousand visitors to the Collection, and the report includes some details of items presented during the year.

Breeding Biology of the Spotted Flycatcher

USING data on the breeding biology of the spotted flycatcher which he had obtained from observations carried out by different investigators at 548 nests, D. Summers-Smith has shown that the normal laying period for this bird in Britain extends from mid-May until the end of July, a small number of birds being double-brooded (*British Birds*, **45**, No. 5, May 1952). The average clutch-size decreases from about 4·5 eggs at the end of May to less than 3 eggs by the end of July. A slightly, but significantly, higher average clutch-size occurs in north England and Scotland than in the rest of England and Wales throughout the breeding season. It is probable that the spotted flycatcher can only successfully rear a brood of five young in Britain when the conditions are very favourable. Summers-Smith also reports that no significant variation in nesting success with season has been detected. The average incubation period is 13·2 days and the nestling period 13·4 days.

An Alternative to Regular Clear-Felling in Forestry

UP to the outbreak of the First World War, at which period the bulk of the woods in Great Britain were on private estates, the general forestry method in force was clear-felling and replanting chiefly with conifers. The true practice of sylviculture and correct forest management, as found in Western Europe and enforced by trained British forest officers in India and a few other parts of the British Empire, was at that time little understood in Britain beyond clear-felling and planting and coppice woods. In a recent issue of *Scottish Forestry* (6, No. 1; 1952), the journal of the Scottish Forestry Society, an article appears entitled "The Alternative to Extensive Regular Clear-Felling", by M. J. Penistan, which shows a considerable departure in practice on a large estate in the south of Scotland. On this estate the management recently decided to limit very extensively the existing policy of clear-felling and replanting, especially in the old hardwood areas. As a result of this decision, an interesting situation arose both from the point of view of instructing the forestry staff and securing enough timber to maintain the estate sawmills—a position which has often faced the trained forest officer overseas in the past over far larger areas than the 650 acres maintained by Mr. Penistan. The difficulties in the management were the outcome of the fellings of the two World Wars. The new treatment is described as mixed forestry, and four so-called new rules are drawn up on sound premises for the existing conditions of the crops: to obtain on every acre a continuous yield of the largest volume of timber; to cut only such timber as is ripe and suitable for conversion; to get rid of all uneconomic growth at an early stage in life and to introduce trees of high quality by natural seed or planting; and to secure conditions for adequate recruitment of timber, that is, enough from which to select fine poles to grow to timber. For a private estate the proposed management is a great departure in forestry practice in Great Britain. Mr. Penistan says that his article, showing how this is to be carried out, has been compiled from the notes made after discussions of the necessary steps to be taken. It is a pity that these notes are not reproduced in a rather more lucid form. To the forester who has been in charge of forest areas managed on professional technical lines they will be understandable; but it may be suggested that some rearrangement would appear to be advisable for those who, though they have not had this experience, may wish to follow Mr. Penistan's admirable departure.

Leicester Museum and Art Gallery: New *Bulletin*

LEICESTER MUSEUM AND ART GALLERY is to be congratulated on the issue of the first number of a *Bulletin*. It is envisaged that each number shall be a coherent whole, and that all articles shall be linked by some common and fundamental idea. The present theme is "Origin", and the second will be "Growth". Regular publication is not promised; but future issues will appear as the necessary material is forthcoming. Following a general editorial article, several examples of origin are discussed. These are arranged in order of their natural development, the earth, the animal, the artefact, recorded knowledge, and art. The first paper thus describes igneous intrusions in the county of Leicester and is followed by a description of the pentadactyl limb and the changes it has undergone in mammalian evolution. An archæologist then stresses, with illustrative examples, the importance of origin; knowledge is represented by a paper on the early history of the Town Library, and art by a discussion of a drawing of two horsemen by Sir James Steuart.

Reporting Research in Education

IN the second pamphlet published by the University of Manchester School of Education (Manchester Univ. Press. Pp. vii+24. 3*s*. 6*d*. net), Stephen Wiseman

has provided some useful information for research students who are preparing their material for publication. The first part of the pamphlet deals with the preparation of a thesis submitted for higher degrees in education and includes useful sections on the length and form of the thesis, the general pattern, outline of the research, statement of the problem, review of the pertinent literature, descriptions of the design of the experiment, description of the techniques, statement of the results, interpretation and discussion of the results, how to summarize the conclusions and the setting out of the bibliography. In the second part of the booklet Wiseman examines how a paper should be prepared for publication and deals with such topics as preliminary planning, the form of typescript to be used, the use of tables and diagrams, the question of proofs, the taking of off-prints and typography. The whole pamphlet is well written and would be of value not only to research students in education but also to those who have investigations to report in any academic study.

Petroleum Films Bureau

The Petroleum Films Bureau has recently published its 1952 list of 35-mm. and 16-mm. documentary and instructional films. It contains certain features not found in the previous 1951 list, and included among the new films are "Oil for the 20th Century", "The Persian Oil Dispute", "Grangemouth Project", "Air Parade", "Highlights of Farnborough, 1951", "Model Flight", "Festival Log Book", "XXIst Monte-Carlo Rally 1951", "An Introduction to the Heat Engine", "Machining of Metals", "The Gas Turbine goes to Sea", "Weed Control", and also some additions to the film magazine series. All 16-mm. films are printed on 'non-flam' stock; the 35-mm. films are on 'flam' stock. As previously, films are available free of charge (return postage to be paid) to educational institutions, societies, clubs and the like, and application should be made to the Bureau at 29 New Bond Street, London, W.1.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: E. G. Harmer (senior produce officer, Department of Marketing and Exports, Nigeria), principal produce officer, Department of Marketing and Exports, Nigeria; F. A. Squire (entomologist, Sierra Leone), director of tsetse control, Gold Coast; R. M. Arnold (veterinary investigation officer, Jamaica), deputy director (livestock), Jamaica; K. D. S. Macowan (senior veterinary officer, Kenya), deputy director of veterinary services, Kenya; E. P. Rice (senior veterinary officer, Kenya), assistant director of veterinary services, Kenya; J. G. Ross (veterinary officer, Cyprus), veterinary officer, Uganda; Dr. F. D. Ommanney (principal scientific officer, East African Marine Fisheries), director of the Regional Marine Fisheries Research Station, Singapore; D. R. Brewin and B. R. Tarr, agricultural officers, Tanganyika; E. L. Drake, entomologist, Nyasaland; A. D. S. Duff, plant pathologist, Kenya; L. J. Hart, agricultural chemist, Tanganyika; R. J. Harvie, agricultural officer, Uganda; W. Hirst, botanist (plant pathologist), Uganda; O. T. Roberts and R. A. Sands, agricultural officers, Kenya; A. L. Wharton, plant pathologist, West African Cocoa Research Institute, Gold Coast; A. J. Radford, government chemist, Mauritius; B. Douglas, assistant conservator of forests, Northern Rhodesia; J. A. Seymour, geologist, Somaliland Protectorate; W. Hardie, veterinary officer, Fiji; B. M. Brown, meteorologist, Nigeria; L. J. Dyke, field officer (research), Mineral Resources, Uganda; F. C. F. Wickery, technical assistant, Mineral Resources (Research) Committee, Uganda.

Announcements

Prof. P. A. M. Dirac, Lucasian professor of mathematics in the University of Cambridge, has been awarded the Planck Medal for 1952. This Medal is awarded annually by the Association of German Physics Institutes for special accomplishments in theoretical physics which have a connexion with Planck's work. The Medal was founded some twenty years ago and the first recipient was Planck himself. The award is announced to the recipient each year on Planck's birthday, April 23, and the presentation is made at the autumn meeting of the Association of German Physics Institutes.

A dinner to mark the centenary of Sir William Ramsay (see *Nature*, October 4, p. 554) will be held at University College, London, on October 15. The guest of honour will be H.R.H. The Duke of Edinburgh.

An exhibition illustrating the work on logic of W. Stanley Jevons has been arranged in the Christie Library of the University of Manchester, and will be open during October 15–31. It includes Jevons's original logical machine, loaned by the History of Science Museum, Oxford, and more modern machines.

The Committee of Privy Council for Agricultural Research and Nature Conservation has re-appointed Prof. G. R. Cameron, Sir James Turner and Sir James Scott Watson to membership of the Agricultural Research Council for a further term. The Committee has also appointed, after consultation with the President of the Royal Society, Prof. E. J. Maskell, Mason professor of botany in the University of Birmingham, Prof. P. B. Medawar, Jodrell professor of zoology and comparative anatomy in the University of London, Prof. L. P. Pugh, professor of veterinary medicine in the University of Cambridge, and Prof. J. S. Young, professor of pathology in the University of Aberdeen, to fill the vacancies caused by the death of Prof. F. T. Brooks and the retirement from the Council of Prof. A. C. Chibnall, Sir Thomas Dalling, Sir Alan Drury and Dr. Joseph F. Duncan.

The Manson Lectures for 1952 of the Royal Institute of Philosophy, on the general topic, "Mind and its Place in Nature", will be given at University Hall, 14 Gordon Square, London, W.C.1, on Fridays, at 5.30 p.m., beginning October 17. The speakers will be Prof. J. Z. Young, Dr. C. G. Phillips, Dr. Macdonald Critchley, Dr. O. L. Zangwill, Prof. A. W. P. Wolters and Dr. A. C. Ewing.

The Printing, Packaging and Allied Trades Research Association is holding a conference and exhibition at the Jackson Hall, Westgate Street, Cardiff, on October 27, at which there will be two sessions, on "Research and the Printer" and a "Brains Trust", respectively. The whole programme will be repeated at the Grand Hotel, Bristol, on October 29, where in addition there will be a technical discussion on October 30 and a further viewing of the exhibition. Further information can be obtained from the Association at Patra House, Randalls Road, Leatherhead, Surrey.

ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION

THE ninety-seventh annual exhibition of the Royal Photographic Society was opened in London on September 12 for one month and will also be shown in the City Art Gallery of Leeds during October 25–November 23 and in the Art Gallery of Bristol during December 6–31. The exhibition is divided into seven sections: pictorial, scientific, medical, nature, stereoscopic, record and kinematic photography, with a total of 849 exhibits.

Within the Scientific Section, exhibits confined to photographic applications of physics and chemistry are small in number, though not in quality, while entries of biological interest are reasonably well represented. The Aerodynamics Division of the National Physical Laboratory is showing three prints consisting of *Schlieren* patterns of the air disturbances emanating from aerofoils mounted in an air current of Mach number 1·6. Two of these prints are in colour and show the various regions of compression and rarefaction by making use of the familiar technique which employs polarized light for the exposure. P. H. Harris shows an electron micrograph of a sheet of etched aluminium foil in which the etching had eaten away the metal, apparently by boring it out in the form of minute tunnels. A. V. C. Cross is exhibiting a series of photomicrographs in which are shown the gradual erosion of a film of rosin naphtha varnish by sea water. A number of aerial survey photographs by Hunting Aerosurveys, Ltd., principally concerned with the site for a dam in Iraq, are of considerable geological interest. In addition, an aerial photograph of the ruined Palace of Persian Kings of Persepolis gives a strong impression of the beauty and splendour that such a building must have possessed in ages past. One of the biological exhibits by H. J. Howard consists of a series of four photomicrographs of progressively increasing magnification from × 10 to × 350 of the apparently simple bird's feather. First the shafts of the feather, then the barbs and finally the barbules are progressively brought into prominence, the fibres of the last interlocking almost at right angles to produce an intricate and effective protection. The selective absorption of silver on the gills of a freshwater crab is shown in an exhibit by S. F. Bush, yet the particulars of what is clearly a process of considerable interest to the chemist are left unexplained. A good example of phase-contrast microscopy by B. A. Jarrett consists of the micro-organism *Stentor roeselii*, in which it can be seen how movements of the cilia enable the cell to swim. An excellent series of colour transparencies by G. H. McLean shows the effects of five different diseases on the leaves of the sugar-beet plant.

In the Medical Section, many of the exhibits hold more than a morbid interest to the lay spectator, because they adequately describe some cycle or technique rather than illustrate some more-or-less distasteful specimen under an obscure Latin title. For example, a virus culture technique shown by the Institute of Ophthalmology, London, is most clearly demonstrated in a series of pictures in which, starting with an eleven-day old fertile incubated egg, part of the shell has been cut away and the egg inoculated. Incubation was continued for about three days, after which the membrane was covered with virus lesions. Perhaps one of the most noteworthy exhibits is from the Hospital for Sick Children, Great Ormond Street, London, in which photographs of a patient taken as a boy and also as a man forty-seven years later show what was probably the first successful surgical removal of a brain tumour with survival over this period. From the same hospital there is also shown, in another exhibit, the system employed for the identification and recording of the particulars of each patient. The technique employed in testing such antibiotics as aureomycin, chloromycetin, penicillin, streptomycin and terramycin is shown by S. E. Veronique. Small paper disks impregnated with the antibiotic are placed on the surface of agar upon which *Staphylococcus* is seeded, and the clear area around the paper disks in which growth of the organism is inhibited is a measure of the effectiveness of the antibiotic. The Manchester Royal Infirmary is showing how enlargement of a radiograph can prove to be worth while, and illustrates this with × 10 enlargements of pathological bone specimens originally exposed on ordinary commercial fine-grain film. Further exhibits by the Institute of Ophthalmology demonstrate techniques and apparatus for retinography and keratography together with colour prints of the human retina. A series of mounts from Guy's Hospital, London, are interesting in that they record limiting movements of the hand, foot or eye either by taking more than one exposure on the same negative or else registering the pictures showing extremes of movement and making tracings from the separate pictures. Photographs of some of the appliances which come to the aid of a hand deprived of normal movement are also shown by K. G. Moreman.

There are numerous excellent exhibits in the Nature and Record Sections of the Exhibition which make it difficult to review with justice; but perhaps the entries on the life-histories of marsh fritillary, gipsy moth, vapourer moth and emperor moth by S. Beaufoy and J. D. C. Boyes deserve special mention.

MODERN METHODS IN THE TREATMENT OF TUBERCULOSIS

THE figures for tuberculosis mortality (England and Wales) since the end of the Second World War show a marked decline. In 1946 the deaths from respiratory tuberculosis were 19,365; in 1950 they were 14,079. In 1946 the deaths from other forms of tuberculosis (bone and joint disease, meningitis, glandular disease) were 3,485; in 1950 they were 1,890.

The mortality from tuberculosis in England and Wales, moreover (with the exception of temporary set-backs during two World Wars), has been steadily declining since 1912, when the national scheme for combating tuberculosis, now merged in the National Health Service, was established. Even allowing for the potential influence of a hypothetical epidemiological cycle, it is not unreasonable to assume that increased knowledge and wisely directed administration have contributed to this decline.

There are certain methods of prevention, diagnosis and treatment which are powerful allies in the anti-tuberculosis campaign. These are as follows.

(1) *Research.* There is close association of research work in tuberculosis with practical application by clinicians. Important work in this field is done by tuberculosis committees of the Medical Research Council, the Ministry of Health, the Prophit Trust of the Royal College of Physicians, the Papworth Research Institute, the Tuberculosis Association and other research bodies. Studies are being made on immunization with B.C.G.

(2) *Pasteurization of milk.* It is estimated that 30 per cent of non-pulmonary tuberculosis is due to infection by bovine strains of the tubercle bacillus, almost always conveyed by milk. In England some 80 per cent of liquid milk is heat-treated, and if only the remaining 20 per cent were so treated a further large reduction in these deaths might well follow.

(3) *X-rays.* In the past twenty years the improvement in X-ray technique has helped the diagnosis of pulmonary tuberculosis and the control of collapse therapy. The value of tomography was established by the work of McDougall and Turning in Great Britain. Lastly came mass radiography, which has developed much of late years for the diagnosis of the early case of pulmonary tuberculosis.

(4) *Surgical treatment.* The extended use of artificial pneumothorax from 1920 onwards marked a great advance. It may be associated, however, with certain severe complications, such as air embolism, spontaneous pneumothorax, empyema and bronchopleural fistula. Difficulties also arise in the termination of an artificial pneumothorax, for the lung will not always re-expand. The type of case, a limited lesion, which did well with this treatment is often treated by chemotherapy to-day. Artificial pneumothorax is still of value in appropriate cases, although some practitioners, especially in Holland, have abandoned it in favour of other surgical measures. Pneumoperitoneum is still employed, both as a useful accessory to chemotherapy and as a temporary procedure to prepare a patient for operation; but phrenic crush, which partly paralyses the diaphragm, often permanently limits respiratory function and is seldom advised. R. Laird is of opinion that thoracoplasty (usually done in two stages) has still a definite place in the treatment of pulmonary tuberculosis. In the six years 1944–50, of 580 patients treated in this way there was a mortality-rate of less than 1 per cent per operation, and 72 per cent of these patients were sputum-negative during the two months before their discharge. Various extrapleural and extrafascial operations may be grouped with thoracoplasties. A one-stage operation followed by no deformity is attractive, but the fate of the dead space and its plastic packing has yet to be determined. Cavity drainage is not often done in Great Britain. Excision of diseased lung formerly had a high mortality from the risk of spread of tuberculous infection. Improvement in operative technique and the use of antibiotics, notably streptomycin, have made pneumonectomy, lobectomy, segmental resection and wedge excision safer and of benefit to many patients unsuitable for collapse therapy. In Laird's series, resection of lung gave a sputum-conversion rate of more than 90 per cent, and the mortality among 132 patients so treated was 4·5 per cent. Despite the increased risk, excision in the United States has largely replaced thoracoplasty, and it is an operation which has now a definite place in treatment.

(5) *Chemotherapy.* The clinical application of antibiotics, streptomycin and *p*-aminosalicylic acid is being actively pursued with encouraging results. Many patients with pulmonary tuberculosis are initially thus treated at home, and, consequently, a higher proportion of those admitted to sanatoria for active treatment have become sputum-negative. This favourably influences medical and surgical treatment alike in sanatoria.

Prevention and treatment must go hand-in-hand in the attack on tuberculosis. As infected cases in the community become fewer, so will the prevalence and mortality of the disease further decline. The new methods of treatment here discussed are highly encouraging; but the older and simpler methods of prevention, notification, contact examination, environmental hygiene and good nutrition must be associated with them.

ARTHUR MACNALTY

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CARNEGIE UNITED KINGDOM TRUST

REPORT FOR 1951

THE thirty-eighth annual report of the Carnegie United Kingdom Trust, covering the year 1951*, refers to the impeding of the village-hall building programme by the general restrictions on capital expenditure: work proceeded on twenty-one schemes throughout Great Britain, and grant instalments amounting to £11,679 were paid; a sum of £30,000 remains available for schemes approved before the end of 1947 but still awaiting a starting date.

Sums of £15,000 were allocated to the Family Welfare Association and to Family Service Units for the quinquennium. The former is conducting an experiment in the approach to personnel problems from the point of view of community relationships and also another experiment involving the employment of a specially trained worker to deal with problem families as part of the case-load at one of the Association's centres. The Family Service Units undertake practical work in the homes of problem families and, as a corollary, practical research in close association with the field-work of the separate units now established in some of the larger cities. A grant of £6,000 to Stanley House, a community centre in Liverpool for coloured people and their friends, is for a development plan involving structural alterations and provision of additional facilities to make the centre a house of friendship for everyone, irrespective of colour, class or creed. The Joint Committee on Museums Policy is surveying several provincial museums which have been selected as potential centres for installing experimental demonstration galleries embodying the most modern ideas of the technique of presentation.

* Carnegie United Kingdom Trust. Thirty-eighth Annual Report, 1951. Pp. viii+48. (From the Trust, Dunfermline, Fife, 1952.)

The trustees are defraying the cost of twelve small experimental alphabet-into-braille machines, which are to be given an exhaustive trial by the two National Institutes for the Blind and Deaf, and a grant of £2,000 over five years on a diminishing scale has been promised to the newly formed Scottish Institute of Adult Education; also, on certain conditions, £5,000 to the British Association for the Advancement of Science for the adaptation of Down House as a residential centre for scientific work and courses in natural science. The survey of agencies and activities concerned with juvenile delinquency was concluded during the year, and the report is being drafted; Miss E. L. Younghusband's supplementary report on the employment and training of social workers, published in September 1951 under the title "Social Work in Britain", had a very favourable reception. The bulk of the report is devoted to a review of the trustees' policy in regard to music and drama, a field from which they have withdrawn now that it is a statutory responsibility of local education authorities.

ENERGY IN THE SERVICE OF MAN

IT is not yet too late to be worth while directing attention to the series of papers presented in Paris last year under the auspices of the United Nations Educational, Scientific and Cultural Organization (Unesco, 19 Avenue Kléber, Paris 16e). One such theme for discussion is to be proposed annually. The first was "Food and People"; now we have "Energy in the Service of Man", which covers an equally wide field. There is some duplication in the six papers; but this is not very important, as the subject is treated from widely different points of view, the authors being free to express their own opinions.

Sir Alfred Egerton, of the Imperial College of Science and Technology, London, discusses "Civilization and the Use of Energy". This long paper considers energy as a determining factor in the growth of civilization, emphasizing the tremendous effect of the new discoveries in the era following the Renaissance. The extent to which available energy resources are at present utilized is also discussed. There are tables and charts provided, but this very general historical approach does not make easy reading. It provides a background against which the ideas in the other papers can be more usefully assimilated.

Dr. L. C. McCabe, of the U.S. Bureau of Mines, in "World Sources and Consumption of Energy", considers the different forms of energy reserves—those such as coal, oil and nuclear fuels, which will ultimately be consumed, and others like water-power, tides, wind and solar radiation, which are continually renewed. He believes that, even with the present rate of technological advance and ever-increasing energy consumption, the world's annual energy requirements in the year 2000 are not likely to exceed 1 per cent of even the known mineral reserves. There are numerous tables giving precise data.

Dr. G. Eichelberg, of the Federal Polytechnic, Zurich, presents a very thought-provoking paper on the "Utilization of Energy". He emphasizes that solar radiation is the ultimate source of all our energy; the greater part of that which we use is stored as chemical energy, which must be converted to mechanical energy by combustion in a heat-engine plant. Dr. Eichelberg discusses the fundamental thermodynamic relationships and traces the thermodynamic evolution of the steam engine, the steam turbine, the internal-combustion reciprocating engine and finally the internal-combustion turbine. His remark that "for the great air-liners jet-propulsion is therefore scarcely a practical proposition", because of its low fuel-efficiency, is already out-dated. He ends with a mention of the theoretical merits of binary-vapour systems, both with independent and combined circuits, and advocates a more intensive research in the field of solution thermodynamics. There are some revealing statements as to the efficiency of domestic heating and the possibility of greatly improved efficiencies by coupling to industrial plant or the use of heat pumps.

Prof. P. Ailleret, of the National School of Roads and Bridges, discusses "Energy in its International Aspects". Since the geographical distribution of natural sources of energy bears practically no relation to the distribution of human needs, great international exchanges of energy are desirable. He gives very interesting maps which demonstrate world movements of fuel, continental electricity grids and oil and natural gas lines. He gives facts to show the scale on which energy exchanges exist at present. He shows that a continental area is usually adequate to form an economic grid—little gain would accrue from intercontinental linkage. Prof. Ailleret discusses the convenience of different forms of energy from the point of view of transport; the ease of transport of oil and gas and the difficulty of transporting electricity economically over great distances are remarkable. He also considers energy storage: it is, of course, cheaper to carry alumina to the electrical generating station and then transport back the aluminium produced from it than to transmit the electrical power to the mineral source. The aluminium metal, having a higher 'potential' energy content than the alumina, represents a form of energy storage. This paper is full of interesting ideas: it is not so much the facts that are new as the way in which they are presented and their interrelation shown.

Prof. M. S. Thacker, of the Indian Institute of Science, Bangalore, treats "The Role of Energy in the Under-developed Areas". This is also a long paper, and the typographical arrangement is different from that of the remaining contributions. It does not make easy reading, largely because of the author's elaborate prose style. He discusses the comparative development of the countries of the world and the distribution of resources among them, considering the factors responsible for the backwardness of various countries. Finally, he outlines a programme of development, including technical and material assistance. He supports his arguments with many tables and much statistical data.

Prof. F. E. Simon, of the Clarendon Laboratory, Oxford, considers "Energy in the Future". Like Prof. Ailleret's paper, this is a challenging and readable document, which ought to provoke much thought and discussion. This is exactly what was intended of the series. The exposition is masterly in its lucid and scholarly approach, while retaining and exploiting the inherent interest of its theme. After dividing energy into its two main categories of 'free' or ordered energy and 'heat' or disordered energy, Prof. Simon recalls the limitations and difficulties

inherent in converting the latter into the former, as determined by the second law of thermodynamics. This leads to a consideration of the heat pump as an alternative use of the refrigeration cycle. He then discusses the present efficiency of energy utilization in domestic heating and in industry: there are some striking and unpalatable truths revealed here—it is a pity that more of those recently engaged in controversy on these topics had not read Prof. Simon's paper. The next section surveys available power sources: the wind, earth and ocean heat, the tides and water-power. A carefully reasoned account is then given of the prospects of obtaining significant quantities of energy from nuclear sources and from solar radiation: the conclusion is reached that, from a 'peaceful' point of view, the prospects of the latter are fully as great as those of the former, and that an equivalent amount of research ought rightfully to be expended upon it. It is a sobering thought to consider what the ratio actually must be. Finally, Prof. Simon summarizes his views on the prospects for the near and distant future.

Each of the papers has a bibliography attached, and a more extensive English bibliography, prepared by the Department of Scientific and Industrial Research, is included as a final contribution. It will be seen that the papers presented vary from the very general to the rather detailed; but the most successful are those which strike a mean between these extremes. It would be valuable if they could be made available in more permanent form at a reasonable price.

R. H. Macmillan

PHYSICS IN THE UNITED STATES

ANNUAL MEETINGS OF THE AMERICAN PHYSICAL SOCIETY AND OF THE AMERICAN ASSOCIATION OF PHYSICS TEACHERS

THE annual meeting for 1952 of the American Physical Society was held at Columbia University, New York City, during January 31–February 2. The attendance reached the unprecedented figure of 2,215, and approximately three hundred papers were contributed. The twenty-first annual meeting of the American Association of Physics Teachers took place simultaneously at Barnard College. At the joint ceremonial session of the two bodies held in the afternoon of February 1, the retiring presidential address of the Society was delivered by Dr. C. C. Lauritsen, of the California Institute of Technology, who took as his subject "Some Investigations of Light Nuclei"; the Oersted Medal of the Association was presented to Prof. A. A. Knowlton, who responded by commenting on opportunities and rewards in physics teaching[1]; and the tenth Richtmyer Memorial Lecture was delivered by Prof. E. Fermi, who spoke on "Large-Cyclotron Research at the University of Chicago".

At the joint banquet in the evening the after-dinner speakers were Dr. O. E. Buckley, chairman of the board of the Bell Telephone Laboratories and of the Science Advisory Committee of the Office of Defense Mobilization, who described the relationship of the Advisory Committee with the government departments which it is designed to serve, and Prof. R. E. Peierls, of the University of Birmingham, who spoke about the status of physicists in Great Britain.

At the business meeting of the American Physical Society the following were elected to hold office for 1952: *President*, J. H. Van Vleck; *Vice-President*, E. Fermi; *Secretary*, K. K. Darrow; *Treasurer*, G. B. Pegram. The main business before the meeting was to consider urgently the extremely grave financial position of the Society. The treasurer reported that the surplus had been eaten away to such an extent that within a few months the Society would find it impossible to meet its commitments. This was due to the almost explosive expansion of the *Physical Review*, which again increased in 1951 by a thousand pages to a total of five thousand. The Council agreed to attack the problem not by limiting the size of the *Review* and thus excluding many worthy papers, but by increasing subscriptions, etc. The by-laws have been amended so that increased subscriptions may be obtained from members and fellows of the Society; at a recent meeting of the Council these have been fixed for 1953 at 20 and 30 dollars, respectively. The non-member subscription and the page charge for papers and letters in the *Review* have also been increased. An extra charge has been imposed on members who wish to subscribe to *Physics Abstracts*, and a registration fee for meetings has been imposed. The National Science Foundation has agreed to make a generous grant, and this will help to defray the deficits which the *Review* has incurred during 1951 and is bound to incur this year and next.

Twenty-seven invited papers were contributed at the scientific sessions held during the meeting of the American Physical Society. These included a special symposium of the Division of Electron Physics at which M. A. Biondi, P. Kusch and S. A. Korff spoke, respectively, on ionization and recombination processes in the afterglow, the magnetic moment of the electron, and recent developments in the physics of counters. In another session on electron physics, reports were given of the conference on gaseous electronics, held during October 1951, and of the National Bureau of Standards symposium on electron physics, held during November 1951. In the Division of Fluid Dynamics invited papers included one on flows in the vicinity of Mach No. 1 by a member of the Wright–Patterson Air Force Base. In nuclear physics there were contributions by K. T. Bainbridge and V. C. Weisskopf on nuclei, by members of Columbia University on pions, by J. H. Van Vleck on the significance of microwave spectroscopy for the theory of magnetism, and from Great Britain by R. E. Peierls and E. P. George, respectively, on non-local field theories and cosmic rays underground. Other branches of physics were also represented, with three papers on optical physics and others dealing with shock waves, high centrifugal fields and large molecules in biological systems. The complete list of papers, together with abstracts, is given in the minutes of the meeting[2].

The programme of the meeting of the Association of American Physics Teachers included a session of ten contributed papers and two invited addresses. A symposium of four papers by members of the Oak Ridge Institute of Nuclear Studies discussed various forms of nuclear reactors and accelerators. Another symposium was devoted to a discussion of methodology in the teaching of physics and included an address by J. B. Conant.

[1] Published in full in *Amer. J. Phys.*, **20**, 267 (1952).
[2] Published in *Phys. Rev.*, **86**, 579 (1952).

ACTION OF CARBOXYPEPTIDASE ON TOBACCO MOSAIC VIRUS

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THE chemical composition of tobacco mosaic virus has been investigated in considerable detail[1,2]. As a logical expansion of these and other studies, it becomes necessary to investigate the structural characteristics of the nucleic acid and protein moieties of the virus.

Several methods[3–6] are available for the identification of N-terminal groups in peptide and protein molecules, but no generally satisfactory method has been developed for the elucidation of corresponding C-terminal groups. The use of carboxypeptidase for the identification of the C-terminal residue of glutathione was reported by Grassman *et al.*[7], and Lens[8] has attempted to use the enzyme to determine the nature of the C-terminal groups of insulin. Results obtained from a study of the digestion of adrenocorticotropic hormone (ACTH) protein and peptide preparations by carboxypeptidase[9] led one of us[10] to re-investigate the potentialities of this reaction as a general method for the identification of C-terminal groups in polypeptide molecules. In this way the C-terminal groups of insulin, of fractions *A* and *B* derived from oxidized insulin, and of lysozyme were identified[10]; similar results for insulin have been reported by Sanger and Thompson[11], and for lysozyme by Thompson[12]. In the present investigation it has been found that threonine specifically is released by the action of carboxypeptidase on tobacco mosaic virus.

In preliminary experiments, an aqueous solution of a highly purified preparation of tobacco mosaic virus (containing 1·5 mgm. N/ml.) was incubated with carboxypeptidase (0·0028 mgm. enzyme N/ml.) at *p*H 7·0 and 25° for three hours. Enzyme action was terminated by spinning down the virus in the Spinco Model L ultracentrifuge. The presence of 0·8–1·0 per cent of non-protein nitrogen in the supernatant solution suggested that some proteolysis had occurred, and chromatography on paper led to the identification of threonine as the only product of the reaction (Fig. 1,*A*). No further reaction was found to occur when the treated virus was isolated and incubated with higher concentrations of enzyme for 24 hours (Fig. 1,*B*), and no ninhydrin-reacting substances were detected when control supernatant solutions from virus and enzyme, respectively, were chromatographed under the same conditions.

After it had been established that threonine was the only significant product of the action of carboxypeptidase on the virus, experiments were designed to investigate the nature of the reaction and to estimate the amount of threonine liberated. In a typical experiment, an aqueous solution of the virus (containing 1·4 mgm. virus N/ml.) was incubated with carboxypeptidase (0·0028 mgm. enzyme N/ml.) at *p*H 7·0 and 25°. Aliquots of the resulting solution were withdrawn at suitable intervals during a three-hour digestion period, and enzyme action was stopped by addition of 0·1 *N* hydrochloric acid to *p*H 3. After removal of the virus by ultracentrifugation, supernatant solutions were collected and their threonine content estimated by microbiological assay[1] at different

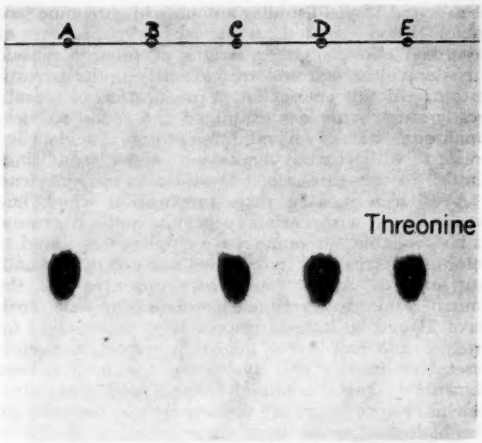

Fig. 1. Chromatography of supernatant solutions from carboxypeptidase-treated virus preparations (butanol/acetic acid/water, 4/1/5). *A*, tobacco mosaic virus-3; *B*, 'dethreonized' tobacco mosaic virus-3, re-treated; *C*, control progeny; *D*, 'dethreonized' progeny; *E*, threonine

dilutions. As shown in Fig. 2, liberation of threonine was essentially complete after 90 minutes and amounted to 74 μgm. threonine/9 mgm. of virus; this corresponds to approximately 7 per cent of the threonine content of the virus. In its initial stages the liberation of threonine appears to be a zero-order reaction with a *K* value of $2{\cdot}0\ (\pm 0{\cdot}4) \times 10^{-3}$ mgm./min.

The tobacco mosaic virus nucleoprotein appears to have a molecular weight of the order of 50,000,000[13]; on this basis it can be calculated that carboxypeptidase liberates more than 3,400 residues of threonine per mole of tobacco mosaic virus. The origin of this threonine is a matter of considerable interest. On the assumption that carboxypeptidase attacks only those peptide bonds adjacent to free α-COOH groups in polypeptide chains, it can be postulated that the protein moiety of the virus complex has more than 3,400 C-terminal threonine groups. As another possibility, one could envisage polythreonine components attached in some way to the virus molecule so that they are readily accessible for stepwise degradation by the enzyme. Several tobacco mosaic virus preparations, and a highly purified preparation of the Holmes's ribgrass (*HR*) strain, have

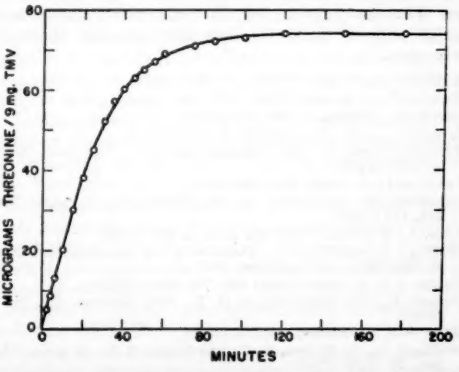

Fig. 2. Rate of liberation of threonine from tobacco mosaic virus-3 by treatment with carboxypeptidase

been found to yield similar amounts of threonine (see table) when treated with carboxypeptidase as described above. Other strains of tobacco mosaic virus and other viruses are currently under investigation. In this connexion, a preparation of tomato bushy stunt virus was examined and found to yield small quantities of several different amino-acids when treated with carboxypeptidase under conditions similar to those described for tobacco mosaic virus.

A tobacco mosaic virus preparation which had been treated with carboxypeptidase until liberation of its available threonine was complete was found to retain full virus infectivity when assayed by the half-leaf method. At the same virus concentrations, the control and 'dethreoninized' tobacco mosaic virus gave 21 and 20 lesions, respectively, as averages for twenty-nine half-leaves. In this respect, the virus resembles insulin and lysozyme, for it has been shown[14,15] that C-terminal alanine and C-terminal leucine, respectively, are apparently not essential for the biological activities of these proteins.

Maximum Yields of Threonine obtained from Tobacco Mosaic and *HR* Virus Preparations by Reaction with Carboxypeptidase*

Virus preparations	μgm. Threonine per 10 mgm. virus
Tobacco mosaic virus-1	81
Tobacco mosaic virus-2	86
Tobacco mosaic virus-3†	82
Control tobacco mosaic virus progeny	93
'Dethreoninized' tobacco mosaic virus progeny	92
HR	88

* See text. † See Fig. 2.

It was of considerable interest to see whether the 'dethreoninized' virus represented a laboratory-produced mutant capable of reproduction in its modified form. To test this possibility, two sets of young, healthy tobacco plants were inoculated with high dilutions of 'dethreoninized' and control virus, respectively. The disease symptoms observed on the two sets of plants were indistinguishable, and, after sixteen days, highly purified preparations of virus were obtained from the plants in the usual manner. When these preparations were treated with carboxypeptidase, it was found that threonine was released from both samples (Fig. 1, *C* and *D*) and that it was released in equivalent amounts (see table). Thus it appears that about 7 per cent of the threonine of the virus can be removed without changing quantitatively or qualitatively the host–virus relationship.

This work is being extended and will be published in greater detail at a later date. We are grateful to Miss Theresa Litwin for the microbiological assay results and to Ning G. Pon for valuable technical assistance.

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ISOLATION OF PORPHOBILINOGEN FROM THE URINE OF A PATIENT WITH ACUTE PORPHYRIA

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THERE is, in the urine of patients suffering from acute porphyria, a substance which gives a red colour with Ehrlich aldehyde reagent. This compound, porphobilinogen, is, so far as is known, only present in the urine of such cases and has, hitherto, never been isolated in the pure state. It has been the subject of study by several workers (Waldenström and Vahlquist[1], Prunty[2], Brockman and Gray[3], and Herbert[4]) since it was originally discovered by Sachs[5]. Waldenström and Vahlquist[1] suggested from diffusion measurements made upon partially purified porphobilinogen that it might be a dipyrrylmethane. They produced evidence that it was convertible under suitable conditions into a 'uro-type' porphyrin and/or porphobilin, a red pigment with urobilinoid characteristics. The view that porphobilinogen is a precursor of uroporphyrin has been generally accepted; but recently Hawkinson and Watson[6] have disputed this. In their view, uroporphyrin arises from an Ehrlich-negative substance.

All investigations, so far, have been carried out on porphobilinogen 'concentrates' of varying degrees of purity. Isolation of the crystalline substance has now provided the opportunity of making a further study of its properties.

Preliminary experiments showed that porphobilinogen was retained on a column containing the cation-exchange resin 'Zeo-Karb 215' and could be displaced by dilute ammonia. Similarly, it was held on the anion-exchange resin 'Dowex 2' and could be recovered with dilute acetic acid or ammonium acetate. By utilizing these resins and also acetic acid-treated alumina (Prunty[2]), concentration has been greatly facilitated, but recoveries have been low—partly due to instability of the compound in solution at room temperature and partly to a considerable loss, by degradation, on the 'Zeo-Karb 215' column. It has been found that porphobilinogen can be completely precipitated from urine by mercuric acetate and recovered without loss by treatment with hydrogen sulphide. Such concentrates are readily freed from accompanying bases and ampholytes by anion-exchange resin and alumina columns.

In a typical preparation, crystalline porphobilinogen has been obtained from the urine of a patient (I. McL.) with acute porphyria (admitted to the Metabolic Ward of University College Hospital under Dr. C. E. Dent and Dr. E. A. Blake Pritchard). 20 l. were adjusted to *p*H 4·5 with glacial acetic acid and shaken with 400 gm. of talc to remove preformed porphyrin. After filtration, warm, saturated, mercuric acetate solution was added in slight excess. The precipitate was washed twice with 1 per cent w/v mercuric acetate. The mother liquor and washings gave no red colour with Ehrlich's reagent (20 gm. *p*-dimethylaminobenzaldehyde in 500 ml. of 36 per cent w/v hydrochloric acid and 500 ml. of water). The precipitate, suspended in 2 l. of water, was saturated with hydrogen sulphide. The filtrate and washings from the sulphide were aerated and an assay carried out which showed that the solution

contained 53·5 units/ml. (Vahlquist[7]) of porphobilinogen. The solution was then passed through a system of columns containing the prepared anion-exchange resin 'Dowex 2'. This set was made up of three glass tubes of decreasing size connected in series with narrow glass tubing (Westall[6]). When all the solution had passed on to the columns, water (500 ml.) was applied, and this was followed by 0·1 *M* ammonium acetate at a rate not exceeding 200 ml./hr. Under these conditions, the coloured substances, which had been carried down with the mercuric acetate precipitation, were firmly held by the resin, while the effluent containing porphobilinogen was practically colourless. This was collected in 50-ml. fractions which were assayed (Fig. 1). The total recovery was 86,000 units (80 per cent). Paper chromatography of the main fractions revealed the presence, besides porphobilinogen, of two unknown substances, one giving a bright blue and the other a green fluorescence in ultra-violet light.

The richest fractions were combined, and the porphobilinogen was again precipitated with mercuric acetate. After removing mercuric sulphide and hydrogen sulphide as before, the solution (300 ml.) was applied to an alumina column previously treated with acetic acid (Prunty[2]) and washed with water. The column (diameter 3·5 cm.) contained 80 gm. of alumina (Savory and Moore, Ltd.). A narrow dark band of porphobilin remained at the top of the column, and just below this a yellow band (the green fluorescent substance) was observed. The substance which gave the blue fluorescence in ultra-violet light passed quickly through in the effluent, and by following the original solution with several applications of water this substance was completely eluted before porphobilinogen was detected in the effluent. 0·1 *N* ammonia was run on to the column, and porphobilinogen was eluted, contaminated only with ammonia and ammonium acetate. On adjusting the solution to *p*H 4 with acetic acid, the free base crystallized immediately. After standing overnight at 0° C., the crystals, which were faintly pink in colour, were filtered, washed thoroughly with water and dried over phosphorus pentoxide. The first crop yielded 210 mgm., and a further crop of 90 mgm. was obtained by rechromatographing the tail fractions which were contaminated by material from the yellow band. The final yield was approximately 40 per cent of that calculated to be present in the original urine.

Properties of porphobilinogen. The pinkish-white crystals (Fig. 2) darkened on heating to 120–130° C. and decomposed with evolution of gas at 175–180° C.

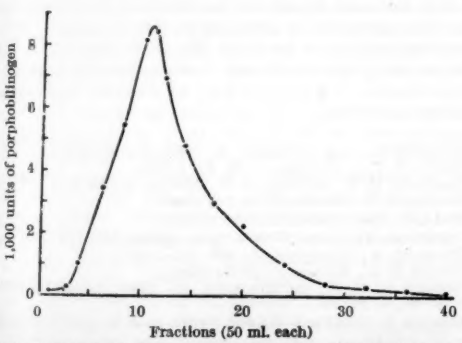

Fig. 1. Porphobilinogen content of fractions displaced from a column of 'Dowex 2' resin by 0·1 *M* ammonium acetate

Fig. 2. Porphobilinogen crystals. × 480

Microanalysis gave the following—found: C, 52·75; H, 6·80; N, 12·08 per cent; $C_{10}H_{16}N_2O_4$ requires C, 52·64; H, 7·02; N, 12·28 per cent. Approximately one-half (6·5 per cent) of the total nitrogen was liberated as nitrogen by nitrous acid in the Van Slyke apparatus, and a similar amount (5·9 per cent) was obtained as free ammonia on distillation in phosphate buffer (*p*H 8·5) at 100° C. No ammonia was obtained, however, when the distillation was carried out at 40° C.

Porphobilinogen crystals were almost insoluble in cold water and in the common organic solvents; they dissolved readily in dilute ammonia and could be recrystallized by bringing the solution to *p*H 4 with acetic acid. The use of sodium or potassium hydroxide instead of ammonia and subsequent neutralization with hydrochloric acid or acetic acid caused the solution to darken quite rapidly. Using Vahlquist's[7] technique and definition, the crystals were assayed at 130 units/mgm. On dry-heating a few crystals to 170° C. and dissolving the residue in dilute hydrochloric acid, the red fluorescence typical of porphyrins was observed under ultra-violet light, and paper-chromatographic analysis using lutidine (Nicholas and Rimington[9]) revealed a slow-moving spot due to 8-carboxyl porphyrin together with faster-moving weaker spots probably due to other partially decarboxylated porphyrins. Porphobilinogen formed a readily crystallizable hydrochloride which was soluble in water but less soluble in 2 *N* hydrochloric acid, m.p. 165–170° C. (decomp.).

Uroporphyrin formation from porphobilinogen. Solutions of porphobilinogen in inorganic buffers darkened on standing in the light at room temperature with the formation of a purplish-red pigment which, on reaching a critical solubility, formed a black deposit. This material gave the typical absorption band of porphobilin and a positive biuret but negative Ehrlich aldehyde test; there was no evidence of any trace of uroporphyrin. If, however, similar porphobilinogen solutions were boiled, with or without the presence of buffers at any *p*H between 1 and 8, a proportion of uroporphyrin was formed and was identified chromatographically as an 8-carboxyl porphyrin. Herbert[4] maintained that the maximum

Table 1. Conversion of Porphobilinogen to Uroporphyrin

Solutions containing 202 μgm. porphobilinogen heated for 20 min. at 100° C. (vol. 2 ml.)	Uroporphyrin formed (μgm.)	Conversion (per cent)	Conversion allowing for loss of ammonia (per cent)
Sodium acetate buffer			
*p*H 4·2	27·3	13·5	14·8
0·05 *N* HCl	49·2	24·4	26·8
0·1 *N*	63·4	31·5	34·8
0·2 *N*	70·1	34·6	38·2
0·5 *N*	78·7	39·0	42·8
1·0 *N*	62·1	30·8	33·8
2·0 *N*	48·6	24·1	26·5
5·5 *N*	17·1	8·5	9·4

uroporphyrin yield was obtained by boiling porphobilinogen solutions in the presence of 0·05–0·2 *N* hydrochloric acid and that the presence of buffer salts led to lower yields. This view has been confirmed in the present work, except that it would appear that slightly greater strength of hydrochloric acid (0·3–0·5 *N*) is required for optimum conversion to uroporphyrin (Table 1).

In an early experiment, using a 'Dowex 2' resin for separating porphobilinogen, a number of serial fractions containing this substance were assayed for the colour given by Ehrlich's reagent and also for the uroporphyrin developed by boiling with acetate buffer at *p*H 4·2 for twenty minutes (the optimum conditions were then unknown). These results, which are presented graphically in Fig. 3, indicated that a constant ratio existed between the Ehrlich colour and the uroporphyrin yield throughout the fractionation. If some substance other than porphobilinogen was yielding uroporphyrin, some variation, however slight, of this ratio would have been expected.

Paper chromatography of porphobilinogen. Porphobilinogen can be detected on paper chromatograms (Consden, Gordon and Martin[10]) in amounts as small as 0·25 μgm. by spraying with Ehrlich's reagent. By this means it has been possible to assess the purity of the various fractions obtained during the isolation procedures. It is also possible to demonstrate the formation of uroporphyrin from porphobilinogen by heating the paper strips for fifteen minutes at 100° C. in a vessel containing acetic acid vapour and then viewing under ultra-violet light. This test, however, is not as sensitive as the Ehrlich reagent, and it is necessary to use 3–4 μgm. of porphobilinogen. A number of fractions containing porphobilinogen and also solutions of the pure substance have been run on duplicate paper strips using different solvent mixtures. After drying, one strip was sprayed with Ehrlich reagent, while the other was heated for uroporphyrin development. In all, six different

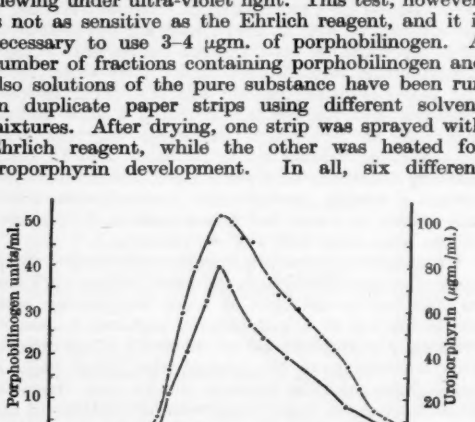

Fig. 3. Comparison of the Ehrlich colour reaction with the yield of uroporphyrin obtained on fractions containing porphobilinogen displaced from a column of 'Dowex 2' resin by 0·1 *N* hydrochloric acid. Upper curve, porphobilinogen; lower curve, uroporphyrin

Table 2. Development of Paper Chromatograms for Porphobilinogen (Ehrlich's reagent) and, after heating, for Porphyrin (fluorescence)

Solvent mixture			*R*F Ehrlich reagent	*R*F Fluorescence (ultra-violet)
Phenol–ammonia			0·50	0·50
Collidine–lutidine			0·08	0·08
*Ethyl acetate	50 ml.	top layer	0·17	0·17
Pyridine	22·5 ml.			
Water	50 ml.			
*Propanol	60 ml.	miscible	0·38	0·38
Ammonia (0·880)	30 ml.			
Water	10 ml.			
Ethyl acetate	25 ml.	top layer	0·27	0·27
Acetic acid	5 ml.			
Water	20 ml.			
†Butanol	40 ml.	top layer	0·51	0·51
Acetic acid	10 ml.			
Water	50 ml.			

* Hanes and Isherwood[11]. † Partridge[12].

solvent mixtures have been used, and in every case the position (*R*F value) of the Ehrlich-reacting spot has coincided with the position of the uroporphyrin (Table 2).

Discussion. While the results recorded above concerning the elementary composition of porphobilinogen, its basic properties, reaction with nitrous acid and its conversion to uroporphyrin, etc., when taken in conjunction with established facts concerning the biosynthesis of protoporphyrin, obviously suggest certain structural possibilities, it is felt that any present discussion of these would be premature. Porphobilinogen, the excretion of which represents the main apparent metabolic error of the acute porphyria patient, is not necessarily a normal step in the biosynthesis of uroporphyrin, and *in vitro* yields of uroporphyrin from it have not, so far, exceeded 40 per cent; moreover, some conversion also occurs, under the same conditions, to porphobilin, a pigment having urobilinoid rather than porphyrin characteristics.

A molecular weight cannot yet be assigned to porphobilinogen, so the question of its pyrrolic or dipyrrylmethane character must remain open. The substance is unstable, and experimental work with it presents many difficulties. The investigation is proceeding along both chemical and pharmacological lines in collaboration with Prof. C. Rimington and Dr. W. D. M. Paton, and a full account will be published in due course.

I wish to thank Prof. C. Rimington for advice and encouragement and for carrying out the Ehrlich and uroporphyrin assays. I am also indebted to Mr. J. Smiles and Mr. J. Harmer, of the Optical Department of the National Institute for Medical Research, for the photograph of crystalline porphobilinogen. The microanalyses were made by Mr. F. H. Oliver, of the Microanalytical Laboratory of the Organic Chemistry Department, Imperial College of Science and Technology, London.

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LETTERS TO THE EDITORS

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Motor End-Plate Differences as a Determining Factor in the Mode of Action of Neuro-Muscular Blocking Substances

In consequence of the results obtained with decamethonium in the cat[1,2] and in human beings[3], we felt justified in putting forward the thesis that decamethonium produced a neuromuscular block in mammals only through a persisting depolarization of the motor end-plate. But work undertaken with other mammalian species (monkeys, dogs, hares) during the past few months reveals that decamethonium can produce in these three a neuromuscular block which differs in many ways from the block produced by pure depolarization. Thus in these species the tetanus is poorly sustained, and antagonizes the block, which is also antagonized by anticholinesterases. The white muscles show an acute decreasing sensitivity to decamethonium, a second injection of a dose which at first produced almost complete paralysis failing to produce any effect. If one records simultaneously from a red muscle and a white one[4], a transition from a depolarizing type of block to a block by competitive inhibition is seen.

Succinylcholine, a pure depolarizing substance, when used on the cat, gave similar results to decamethonium on the monkey and the dog. These findings clearly indicate that decamethonium and succinylcholine can no longer be described as purely depolarizing substances in these species. What, then, are they? Undoubtedly they are not just competitive inhibitors, because in the first place they produce features of a depolarizing substance, and in the second place the muscles of the species under consideration show an acute decreasing sensitivity to decamethonium and to succinylcholine. Such a result is never obtained from a competitive inhibitor like *d*-tubocurarine. The impression resulting from the study of these facts is that the picture obtained in the monkey and the dog is similar to that obtained in the cat when an injection of *d*-tubocurarine is interposed between the first and subsequent doses of decamethonium.

A tentative suggestion I should like to put forward is that there may be a dual mode of action of decamethonium and succinylcholine upon the muscles of these animals. It seems possible that, while the molecules at first adhere in the specific way necessary to produce a depolarization at the end-plate, their grip eventually changes, with the result that from depolarizing substances they become competitive inhibitors.

This idea is strengthened by two other observations. A higher member of the same series as decamethonium, tridecamethonium, produces in the cat a similar picture to that produced by decamethonium in the monkey and in the dog. This shows that if the polymethylene chain is lengthened, the molecule loses the specific property required to produce a neuromuscular block by pure depolarization even in the cat. The other observation relates to the action of these substances on avian muscle[5]. In birds, *d*-tubocurarine produces the usual paralysis, whereas decamethonium and succinylcholine produce a pure contracture characterized by extension of the limbs and retraction of the head[6]. If the dose is small, recovery is abrupt; if large, the animal dies in contracture and never exhibits paralysis. But when an injection of tridecamethonium is given, a completely different picture is produced. First contracture appears; but slowly, while the legs are still extended, the head drops forward in paralysis and finally the paralysis extends to involve the muscles of the leg so that the whole animal becomes flaccid. In the bird, as in the monkey, we start with a decamethonium picture and finish with a *d*-tubocurarine one.

Hitherto it has generally been assumed that results obtained from experiments upon one mammal could safely be regarded as typical for mammals in general. It is now clear that results obtained from the muscle of any one mammalian species are valid only for this species, and perhaps for the particular muscle upon which the experiment was made.

These findings seem to provide an explanation for the varying sensitivity of different species to decamethonium. In species where depolarization is the only mode of action of decamethonium, sensitivity is great. But immediately the dual mode of action comes into play, the muscle becomes more resistant to decamethonium, most probably because these two modes of action are antagonistic.

The variations of the cat, monkey and dog muscles in response to substances like decamethonium and succinylcholine show that there must be distinct physical differences between the muscle membranes of these mammalian species, in spite of the similarity of their reaction to acetylcholine—a fact revealed so far only by such pharmacological analyses. These normally occurring differences in certain species may appear as pathological changes in the muscles of any one species. Taking into consideration results obtained by Churchill-Davidson and Richardson (see succeeding communication), we may reasonably conclude that the myasthenic syndrome is due to changes developing at the motor end-plates of these subjects; these changes make them react to their own acetylcholine as if acetylcholine were a competitive blocking substance.

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The exact mechanism responsible for the muscle weakness and rapid fatigue characteristic of myasthenia gravis remains unknown, although it has long been recognized to be associated with a failure of neuromuscular transmission. Three main factors have been suggested as the possible cause of this neuromuscular block: first, a reduction in the amount of acetylcholine liberated at the myoneural junction; secondly, an excessive rate of its destruction due to increased esterase activity; and thirdly, the prevention of its depolarizing action on the motor end-plate by a curare-like substance.

There is no adequate evidence to indicate an abnormality in the production or destruction of acetylcholine in myasthenia, and one could not

explain on such a basis the properties of the neuromuscular block found in this condition. This block exhibits the properties of one due to competitive inhibition in that it is greater at high rates of neuromuscular stimulation and reversed by substances having only an antagonism for competitive block in common; for example, neostigmine, tetraethylpyrophosphate, adrenaline and potassium salts. Direct evidence for the presence of a curare-like substance is based on the claim of Wilson and Stoner[1] to have detected it in blood samples obtained from myasthenic patients. Their claim, however, remains unconfirmed.

Recent investigations into the action of decamethonium salts on voluntary muscles indicate that another mechanism must be considered as a factor in this abnormal neuromuscular transmission of myasthenics. In normal human muscles decamethonium (*C*.10) has been shown to produce neuromuscular block by depolarization[2], such as it does in certain other species; for example, the cat[3,4]. Electromyographic recordings taken from normal human muscles show that the characteristic features of such a decamethonium block are that it is potentiated by anti-cholinesterase substances; twitch and tetanus are equally well sustained; a steady but progressive fall in the height of the action potential follows the administration of the drug, and finally, muscle twitches and tightness are a marked feature, especially in the jaw and calf muscles.

The muscles of myasthenic patients, however, show a very different response. We have previously demonstrated that they exhibit a diminished sensitivity to the neuromuscular blocking action of decamethonium which is most marked in those muscles showing little clinical weakness[5]. We have now carried out further investigations into the neuromuscular block that can be induced in the clinically weak muscles of myasthenic patients by decamethonium and have observed that it differs radically from that induced in the muscles of normal subjects under identical conditions. The block in myasthenic muscle is rapidly and completely reversed by anti-cholinesterase substances; tetanic rates of stimulation are not so well sustained as twitch; there is often a marked and prolonged rise in the height of the action potential following decamethonium, and muscle twitching and tightness are absent in this group of subjects. These changes in the mode of response of myasthenic muscle to decamethonium can only be explained by the production of a neuromuscular block due to competitive inhibition by this compound. They are in contrast to the depolarizing block induced by decamethonium in normal subjects.

The conception of decamethonium acting as a competitive inhibitor in myasthenia could be accounted for in two ways: first, by an alteration in the composition of the drug, and secondly by a change in the mode of response of the receptor—the motor end-plate. Biological assays of the urine of our myasthenic patients and normal control subjects show that in both groups the decamethonium is excreted at identical rates and unchanged. It must be concluded, therefore, that in cases of myasthenia gravis the affinity of the motor end-plate for decamethonium changes, so that its threshold is raised for this compound and a block characteristic of competitive inhibition results.

A dual mode of action of decamethonium is suggested by Zaimis in the preceding communication. Her observation that tridecamethonium, decamethonium and succinylcholine exhibit this dual action in different species and, indeed, in different muscles of the same species, leads us to suggest that acetylcholine—a depolarizing substance for all normal muscle—may under certain conditions exhibit this dual mode of action. When it does so in the human species, the result is the weakness and fatigue characteristic of myasthenia gravis.

We believe that the production of competitive inhibition of neuromuscular transmission by decamethonium and acetylcholine in myasthenia can result from changes in the motor end-plates. This hypothesis would explain our results and all the features of the disease, including notably the involvement of isolated muscles.

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An Antifungal Polypeptide produced by *Bacillus subtilis*

During work on cultures of *Penicillium roqueforti*, a contaminant was isolated which caused pronounced inhibition of the growth of that mould. The contaminant, when purified and characterized according to Bergey[1], proved to be *Bacillus subtilis*.

The isolate, when grown in shallow broth cultures on the medium used in the production of mycosubtilin[2], produced active solutions. Activity was determined according to the procedure described by Turner-Graff[2], with *P. roqueforti* as test organism. The optimum temperature was 25°–30° C., and maximum yield was obtained in four to six days. The cell-free fluid was active up to a 1 : 10 dilution.

The following procedure was developed for the preparation of the inhibitor. The cell-free fluid from cultures grown as described above was extracted with half its volume of *n*-butanol. The butanol layer was separated and vacuum-distilled at 60°–70° C. A viscous brown residue was obtained which was taken up in water and treated with hydrochloric acid until there was no further precipitation. The precipitate was separated and dissolved in a minimum amount of sodium hydroxide. The solution was diluted with water and reprecipitated with hydrochloric acid. The precipitate was rinsed with water and dissolved in a small volume of ethanol. The solution was then treated with an excess of ethyl ether, and a voluminous white-to-brown precipitate was obtained. Further purification was accomplished by repetition of the above alcohol–ether procedure. The ether precipitate was filtered and dried at 105° C. to a yellow-brown substance.

The inhibitor proved to be a non-dialysable heat-stable polypeptide. It gave positive biuret and xanthoproteic reactions. The Molisch test was negative. The nitrogen content of the dried product was 11–11·5 per cent.

A single counter-current distribution run with 25 tubes, in the system *M*/10 phosphate buffer *p*H 8·7

and *n*-butanol, indicated that the peptide was homogeneous. It is an acid polypeptide with a *p*K of about 5·5 and an equivalent weight of approximately 1,000 when titrated with sodium hydroxide. The polypeptide is insoluble in distilled water, soluble above *p*H 6. It dissolves without difficulty in methanol, ethanol and *n*-butanol.

Paper-partition chromatography of an acid hydrolysate with a phenol – water system using the capillary ascent method of Williams and Kirby[4] showed the presence of seven amino-acids. Glutamic acid predominated. The other amino-acids identified were aspartic acid, serine, alanine, valine, leucine and phenylalanine.

The antibiotic spectrum of this compound is now being investigated. Results obtained so far indicate that it is active against *Penicillium roqueforti* at concentrations of 0·05–0·1 mgm./ml., and against *Aspergillus niger* at 0·2 mgm./ml. At these concentrations, there was no effect on *Staphylococcus aureus*, *Klebsiella pneumoniæ*, *Escherichia coli*, *Streptococcus fæcalis* and *Streptococcus lactis*.

The inhibitor is therefore mainly antifungal. A comparison of its properties with those of the other two known antifungal polypeptides produced by *B. subtilis*, mycosubtilin[3] and fungistatin[5], shows it to be different.

A more detailed report of this work will be published elsewhere.

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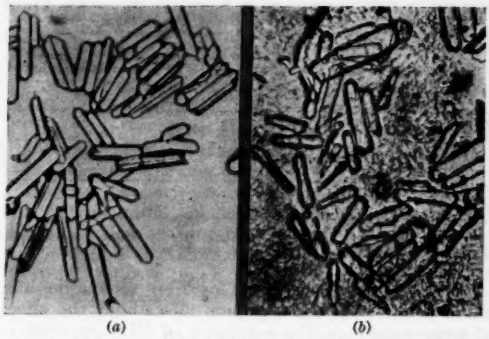
Lipoid Solubility as a Factor in the Toxicity of Contact Insecticides

Contact insecticides as a class are lipoid-soluble, and it is reasonable to surmise that the first step in their uptake or pick-up by the insect might be generally their dissolution in the epicuticular waxes. All the same, experimental evidence of this phenomenon does not seem to exist, and relative solubility of insecticidal chemicals in cuticular waxes of insects has not been studied so far as known to us. Recently, it has been possible to develop a fairly handy technique for such studies and to collect thereby some experimental evidence of the existence of correlation between lipoid solubility and insecticidal action.

Lipoid solubility. Cuticular waxes were extracted from the larval exuviæ of two species of insects, namely, *Euproctis lunata* Wlk. (Lymantridæ, Lepidoptera) and *Trogoderma granaria* Everts. (Dermestidæ, Coleoptera), which had been found in earlier experiments to show very wide differences in their susceptibility to suspensions of DDT crystals. The extract from *E. lunata* formed 2·95 per cent of dry weight of the exuviæ and was a grease-like wax with a deep yellowish-green colour and a melting point range of 47–54° C. That from *T. granaria* formed 3·93 per cent of the dry weight of the exuviæ and was hard brittle wax, light yellow in colour and with a melting point range of 77–83° C. Both were readily soluble in cold chloroform, benzene and xylol, and were sparingly soluble in alcohol and acetone. In order to study the solubility of DDT in these extracts, they were dissolved separately in chloroform, giving a 0·05 per cent separate solution of each. Then 1 c.c. of this solution was spread uniformly on a glass cover slip (2·25 cm. square) and the chloroform allowed to evaporate, leaving a more-or-less uniform wax film on the cover slip. Taking the relative density of insect waxes as 0·96 gm./c.c.[-1], the approximate thickness of this wax film was about 10 μ. The films thus made from the two cuticular extracts were uniformly sprayed under a spraying tower with a suspension of DDT crystals (8 × 32 μ in size), in acetone – water medium, and examined under the microscope. Particular areas on the film were marked out, and the fate of the DDT crystals in those areas observed at very short intervals. It was observed that: (*a*) as soon as the crystals settled on the wax films they started sinking into the wax; this process was very rapid in the case of *Euproctis* wax, the crystals being completely covered by wax in about one minute, whereas the same process took 15–30 minutes in the case of *Trogoderma* wax; (*b*) DDT crystals started showing signs of dissolution (see accompanying illustration) within five minutes and completely disappeared in 30–45 min. on *Euproctis* wax, whereas very few crystals showed any sign of dissolution on *Trogoderma* wax during the corresponding period; (*c*) a few crystals which were left undissolved on *Euproctis* wax were found on close examination to be enveloped in a film of water which obviously hindered their dissolution. No such reason could be adduced for DDT crystals not dissolving on *Trogoderma* wax.



(*a*) (*b*)

DDT crystals: (*a*) on glass slide, and (*b*) on film of *Euproctis* wax showing signs of dissolution in losing their shape, and dwindling in size. The respective enlargements of (*a*) and (*b*) are not the same

Relative susceptibility. Correlated with the difference in the relative solubility of DDT in the cuticular extracts of the two species, there was a great difference in their relative susceptibility to suspensions of DDT crystals as shown in the accompanying table.

When sprayed grubs of the resistant species *T. granaria* were observed under the high power of a binocular microscope, the DDT crystals could be easily detected even after a week with their outline more or less intact on the insect body, indicating that the DDT crystals were not being absorbed quickly.

Toxicity of DDT Crystals to *E. lunata* and *T. granaria* Larvæ Under Almost Identical Conditions

% concentrations	Mortality % in *E. lunata* 4 days after spraying				Mortality % in *T. granaria* 50 days after spraying			
	S	*M*	*B*	*C*	*S*	*M*	*B*	*C*
0·125	80	80	64	73	26	22	28	30
0·0625	62	64	44	56	20	18	8	14
0·03125	44	44	31	38	4	8	2	6
0·0156	31	33	24	27	0	2	0	2
Control	4				0			

S, DDT crystals 2 × 10–12 μ in size; *M*, the same, 4 × 12–16 μ; *B*, same, 8 × 30–32 μ; *C*, same, of nearly colloidal dimension.

Effect of temperature. This film technique also made it possible to have some idea about the effect of temperature on the solubility of DDT crystals in these waxes. Films with DDT crystals on them were kept at 32° C. and in a refrigerator (10–15° C.). It was found in the case of *Euproctis* wax that all the crystals were dissolved within one hour at 32° C., but only a very small number did so even in 24 hours at 10–15° C. The crystals on *Trogoderma* wax showed only slight change at both these temperatures.

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Oxidative Degradation of Testosterone by Adaptive Enzymes

The study of steroid synthesis by micro-organisms and certain oxidations and reductions of reactive groups at positions 3 and 17 of the steroid skeleton have been previously reported[1]. Turfitt[2] has studied more extensive degradations of cholesterol by bacteria and has isolated products in which the side-chain has been removed and ring *A* opened. We should like to report the application of adaptive bacterial enzymes to the study of the oxidative degradation of steroid hormones.

An unidentified, Gram-negative, flagellated bacillus (probably a non-fluorescent *Pseudomonas*), which can utilize testosterone as its sole source of carbon, has been isolated from the soil by enrichment cultures. Colonies growing on agar plates in which testosterone has been finely dispersed produce extensive zones of 'clearing' at some distance from their margins (Fig. 1). When testosterone is the only source of organic carbon in the medium, relatively poor growth of this micro-organism is obtained. We have grown cells as a routine in well-aerated liquid cultures at 30° C. in a medium containing 2·5 mgm. per ml. of finely dispersed testosterone and 2·5 mgm. per ml. water-soluble yeast-extract, in addition to ammonium sulphate and requisite mineral salts (magnesium sulphate, sodium chloride and potassium mono- and di-hydrogen phosphate). Washed cell suspensions of organisms grown in this manner carry out vigorous and extensive oxidations of testosterone. These oxidations may be conveniently studied manometrically with 1–2 μ*M* of steroid suspended in 0·03 *M* phosphate buffer *p*H 7·2 at 30° C. in air. Under such conditions, the activity of oxidation may vary in different preparations from Q = 60–200 μl. oxygen/mgm. dry weight/hr., whereas the endogenous respiration amounts to 20–25 per cent of this. The total oxygen consumption is proportional to the quantity of testosterone added, and usually amounts to 40–60 per cent of the theoretical amount for complete oxidation to carbon dioxide and water. In the presence of critical concentrations of 2,4-dinitrophenol, the total oxygen consumption may approximate to the theoretical for complete oxidation.

Fig. 1. Colonies growing on agar containing finely dispersed testosterone, ammonium sulphate and mineral salts

The enzymes involved in these oxidations are adaptive, as the organism grown on yeast extract alone will not immediately oxidize testosterone. Washed cells grown on yeast extract, when placed in Warburg vessels in phosphate buffer at *p*H 7·2 and 30° C. in air, will, in the absence of an exogenous nitrogen source, become adapted to oxidize testosterone after a lag period of 8–10 hr. The specific activities obtained during *in vitro* adaptation are considerably lower (Q = 5–10 μl. oxygen/mgm. dry weight/hr.) than those achieved by growing the organism in the presence of the steroid.

Testosterone-adapted cells will also vigorously oxidize a series of related 19-carbon steroids, such as androst-4-ene-3,17-dione, androstane-3,17-dione, 17-epitestosterone, dehydroepiandrosterone, epiandrosterone, and dehydroandrosterone. The presence of a side-chain at carbon 17, for example, methyltestosterone, precludes oxidation. Natural œstrogens, such as œstrone and œstradiol, as well as synthetic œstrogens, such as *bis*dehydrodoisynolic acid methyl ether and diethylstilbœstrol, are not attacked by this micro-organism. Adrenal cortical steroids (compound *E*, compound *F* and deoxycorticosterone) are likewise resistant to oxidation.

The terminal oxidative pathway appears to be by way of the tricarboxylic acid cycle, as the oxidation of testosterone is inhibited by tricarboxylic acid enzyme inhibitors (malonate and fluoroacetate), and certain of the cycle enzymes (*iso*citric dehydrogenase and fumarase) have been demonstrated in cell-free extracts of the organism.

Cell-free extracts prepared from washed testosterone-adapted cells by grinding with alumina[3] will carry out the initial oxidation step of testosterone, whereas extracts of unadapted cells grown on yeast fail to do so. The adapted extracts contain a diphosphopyridine nucleotide - specific enzyme which will oxidize testosterone and dehydroepiandrosterone. This enzyme is distinct from ethanol dehydrogenase. The steroid oxidations can be studied spectrophotometrically by measuring the appearance of

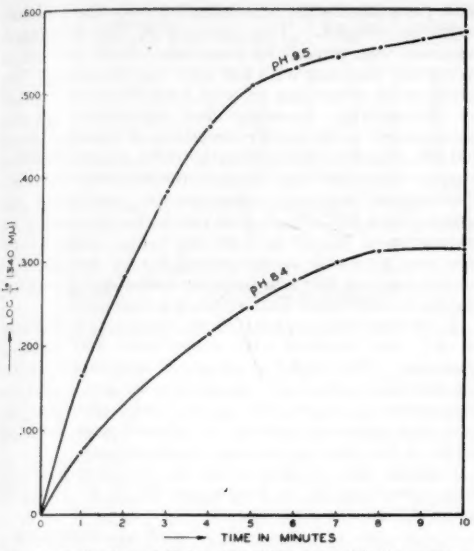

Fig. 2. Reduction of diphosphopyridine nucleotide by enzyme extract of testosterone-adapted cells in presence of testosterone at 25° C. and *p*H 8·4 and 9·5. Optical density readings at 340 mμ, corrected for endogenous reduction of the nucleotide (*c.* 15 per cent of total). System : Phosphate buffer 0·03 *M*, 0·05 ml. enzyme, 0·1 ml. diphosphopyridine nucleotide (0·34 μ*M*), 2·0 ml. aqueous testosterone (0·1 μ*M*). Total volume 3 ml. Reaction started by adding the nucleotide

reduced diphosphopyridine nucleotide at 340 mμ (Fig. 2).

The rate and equilibrium are markedly sensitive to *p*H, the rate being greater at *p*H 9·5 than at lower *p*H, and the equilibrium shifts in favour of the complete oxidation of testosterone as the *p*H of the reaction medium increases. The product of testosterone oxidation has been isolated by paper chromatography (using formamide-impregnated paper and a moving phase consisting of a mixture of equal parts of hexane and benzene) and behaves chromatographically like androst-4-ene-3,17-dione.

A few micrograms of testosterone can be detected by measuring the reduction of diphosphopyridine nucleotide with the aid of this enzyme extract, and fractionation of the latter is being undertaken in the hope of developing a sensitive, specific assay for testosterone and related steroids. Full experimental details will be given in a future publication.

This work was supported by grants from the American Cancer Society, recommended by the National Research Council Committee on Growth and the Jane Coffin Childs Memorial Fund for Medical Research. We are indebted to Chemical Specialties, Inc., New York, and Schering Corporation, Bloomfield, New Jersey, for generous gifts of a variety of steroids.

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Enzymes of *Vibrio cholerae*

BURNET's discovery[1] of an epithelium-desquamating enzyme in *V. cholerae* filtrates has opened up a new line of approach in the investigation of the pathogenesis of cholera.

Using pure collagen prepared by the method of Highberger[2] from buffalo tendo Achillis, we have been able to demonstrate, in culture filtrates of *V. cholerae*, a collagenase with an optimum *p*H of 8·0. This enzyme could not be detected in culture filtrates of *B. coli*. The method employed for this study was as follows. 4-ml. quantities of a Seitz filtrate of an 18–20-hr. culture in 1 per cent nutrient agar of *V. cholerae* (Inaba), after being adjusted to *p*H's ranging from 4 to 9 and made up to the same total volume of 6·4 ml. with distilled water, were treated with 0·2 gm. each of the collagen preparation and incubated for 48 hr. at 37° C. A boiled cholera filtrate – collagen control was also run in parallel. At the end of the incubation period, the undigested collagen was separated off and samples from the clear solution were taken out in duplicate for nitrogen analysis by micro-Kjeldahl method. The average nitrogen content in mgm. per ml. of the solution of closely agreeing duplicates is given in the accompanying table.

Nature of filtrate	*p*H	Nitrogen per ml. of supernatant	Increase in nitrogen/ml. of fresh filtrate incubates over control
V. cholerae, type Inaba	4·0	0·66	0·0
	5·0	0·814	0·154
	6·0	0·941	0·281
	7·0	0·947	0·287
	8·0	0·961	0·301
	9·0	0·918	0·258
Boiled *V. cholerae* filtrate (control)	6·0	0·66	
B. coli filtrate	7·0	0·972	0·013
	8·0	0·995	−0·015
Boiled *B. coli* filtrate (control)	7·0	0·959	
	8·0	1·01	

The increase in the dissolved nitrogen of the collagen–cholera-filtrate incubates over that of the control, with a maximum at *p*H 8·0, shows the presence of a collagenase in *V. cholerae*. This enzyme is capable of acting over a wide range, optimum effect being at *p*H 8·0.

Further work on vibrio enzymes is in progress. The evidence collected so far shows that collagenase is also present to some extent in culture filtrates of vibrios of non-choleragenic origin. Details of these investigations will be published shortly.

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Chromatographic Isolation and Estimation of the Natural Œstrogens from Tissue

THE separate isolation and estimation of the three œstrogens in tissue at present entails the use of a large amount of material, with a separation by partition in solvents which is by no means perfect. The resulting product is very impure and has to be assayed biologically rather than chemically. Various chromatographic and other techniques have been

tried to find a method of purification and separation[1-3], all of which for various reasons were found to be unsatisfactory for tissue extracts.

To avoid streaking, and to give reproducible R_F values for the œstrogens when run on paper chromatograms in the presence of the large amount of greasy impurity found in tissue extracts, it has been found essential to use an elevated temperature under the carefully controlled conditions recently described by Bush[4] for adrenal steroids. On this basis, and utilizing a new spotting technique, a method has been evolved for complete isolation and estimation.

Fresh human placenta has been used for these experiments, and extracts of up to 200 gm. were taken for a single run. The tissue was minced and extracted in a Soxhlet apparatus with methanol, which was removed *in vacuo*; the remaining sludge was extracted with ether. Where a hydrolysate was required, this was obtained by refluxing with 1·5 *N* hydrochloric acid and subsequent extraction with ether. The ether was washed with 9 per cent sodium bicarbonate, removed *in vacuo*, and the residue taken up in benzene. At this stage œstriol was separated from œstrone and œstradiol by thorough extraction of the benzene with water. The water was extracted with ether, and one volume of carbon tetrachloride added to 18 volumes of ether, which was then extracted with *N* sodium hydroxide. The sodium hydroxide was brought to *p*H 9 with sulphuric acid[2] and extracted with ether, which was evaporated to give the œstriol fraction. The œstrone and œstradiol fraction was obtained by extraction of the benzene with *N* sodium hydroxide and subsequent treatment as for the œstriol fraction.

The final extracts dissolved in ethanol were placed on strips, 5 in. by 18 in., of Whatman 541 filter paper, the ethanol being evaporated by a stream of air directed under the paper. (For quantitative work the paper must be extracted with methanol in a Soxhlet apparatus for several hours to remove impurities soluble in methanol.) The chromatograms were run overnight (16 hr.) by the descending technique in glass tanks in a uniformly heated cabinet containing an efficient fan, at 32° ± 0·5° C. The precautions described by Bush[4] regarding saturation of the atmosphere in the tanks must be taken. Equilibration is complete after 1–1½ hr.

The mobile phase for œstrone and œstradiol was made from 1,000 ml. petrol ether (b.p. 100–120° C.), the stationary phase being methanol (1,000 ml.). For œstriol these were, respectively, benzene (1,000 ml.) and a mixture of methanol (500 ml.) with water (500 ml.).

The œstrogens were shown up as blue spots (minimum detectable, 0·5 μgm./sq.cm.) by spraying the paper with Folin and Ciocalteu's reagent[5] freshly diluted with five volumes of water, and hanging in a tank, the bottom of which was covered with 0·88 ammonia solution, until the spots reached maximum intensity (about 5 min.). The papers were dried at room temperature to give permanently stable chromatograms.

The œstrogens in the tissue extract are shown as sharply defined spots with no streaking after a 16-hr. run. The spots are well distributed over the paper, and the R_F values in the respective systems are œstrone 0·2, œstradiol 0·07 and œstriol 0·13.

Quantitative removal of the œstrogens from the paper was achieved by hanging the paper containing the spot at the base of a condenser, and refluxing with methanol for 15 min. In this case, the spots have to be found by running the extracts parallel with pure standards, and spraying only the standard strips so formed. The identity of the substances removed was proved by measuring their absorption spectrum, coupling with azo dye[1] and bio-assay. The amounts of œstrogens present have been determined by fluorimetry, bio-assay and absorption spectrophotometry, with good correlation of results. From 100 gm. of hydrolysed placental tissue, 3 μgm. œstrone, 1 μgm. œstradiol and 10 μgm. œstriol were obtained. Provisional recovery experiments, excluding the action of the hydrolysis, give results for the respective œstrogens of 80, 40 and 60 per cent. Most of this loss may probably be accounted for by trouble with emulsions, and fatty impurities disturbing the distribution coefficients. This is being investigated.

These figures agree with those obtained by Huffman *et al.*[6], who worked with more than 400 kgm. of placenta. The small amount of material required for the above method (minimum 50 gm.), and the comparatively short time taken for complete purification and chemical estimation, should now facilitate work in the field of œstrogen metabolism.

I would like to thank Dr. R. E. Davies for his help, also Prof. H. A. Krebs and Dr. C. G. Paine for interest and encouragement.

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Transplantation of Mouse Sarcoma with Small Numbers of Single Cells

Although transplantation of leukæmia has been secured by the intravenous inoculation of a single leukæmic cell[1], transplantation of a solid tumour by a single malignant cell has not, so far as is known, been demonstrated. The fact that a leukæmic cell can normally exist as an isolated viable cell in a fluid environment is a special feature which has left open the possibility that single cells of a solid tumour may not so well survive the manipulations required for transplantation.

Single-cell suspensions of a spindle-cell sarcoma which arose in this laboratory in a transplantable mammary carcinoma of *C3H* mice have been prepared by prolonged sedimentation under gravity of tumour mince suspended in Tyrode solution containing 0·5 per cent gelatine. It has been found that between 80 and 90 per cent of the cells in such suspensions can be presumed to be non-viable, as indicated by diffusion of trypan blue into the nuclei[2] and by other evidence of degeneration apparent in phase-contrast microscopy. In recording the cell density of a suspension, therefore, account is taken only of the cells of which the nuclei fail to take up dye in the presence of 0·2 per cent trypan blue. 0·1-ml. volumes of serial dilutions of a single-cell suspension were inoculated subcutaneously into *C3H*

Dilution factor	Calculated number of cells in inoculum	Number of inoculations	Number of tumours	Positive inocula (per cent)
100	1,200	12	10	83
300	400	12	10	83
900	133	12	10	83
2,700	44	12	7	58
8,100	15	12	4	33
24,300	5	12	4	33

mice of between two and four months of age. The accompanying table shows the percentage of inocula, containing various numbers of viable cells, which gave rise to progressively growing tumours within the 40-day period of observation. The cell numbers given in the table are calculated from the viable cell density in the original suspension and the dilution factor.

From the table it will be seen that tumours arose from one-third of the inocula containing a calculated number of five cells. When the percentage of tumours arising from the various cell doses is calculated from the accumulated results according to the method of Reed and Muench[3], and plotted against the logarithm of the numbers of cells in the inocula, a sigmoid curve is obtained which approaches zero for both ordinate and abscissa. The number of cells required to give 50 per cent of positive inocula, read from the graph, is 14.

The technical error most likely to result in gross under-estimation of the number of cells in the most dilute inocula is contamination by cell clumps. This possibility is considered to be ruled out by the observations that (1) the viable cells showed no tendency to clump even in the most dense suspensions, and (2) no cell clumps could be seen in a volume of the undiluted suspension which contained 12,000 viable single cells. Other technical considerations, such as the possibility that a proportion of the cells not taking up trypan blue may nevertheless not be viable, and that some cells may be lost or damaged in the course of inoculation, make it probable that less than five cells was in some cases responsible for starting a fresh tumour. Since the volume of the inocula was 0·1 ml., it must be presumed that the single cells in the most dilute inocula were deposited in the tissues at some distance from one another. Assuming that such cells have no influence on one another, it must be concluded that fresh tumours arose from single isolated cells.

The necessity of absolute criteria for the exclusion of cells from the inoculum in experiments intended to demonstrate cell-free transmission of tumours is made clear when it is realized that, as implied by the results here reported, a tumour can result from the inoculation of 10^{-6} c.mm. of tumour tissue.

Similar experiments to the above have shown that about 2,000 viable cells of sarcoma 37 are required to give 50 per cent of positive inocula in a colony of mice uniformly susceptible to massive grafts. No successful transplantations have resulted from the inoculation of single-cell suspensions of transplantable *C3H* mammary carcinoma into *C3H* mice.

A more detailed report of these investigations will be published elsewhere in due course.

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Possible Identity of 'Lactobacillin' with Hydrogen Peroxide produced by Lactobacilli

Strains of lactobacilli were recently isolated from Gruyère cheese which gave zones of inhibition against *Staphylococcus aureus* 20–30 mm. in diameter. This inhibition appeared to be antibiotic in nature, perhaps similar to that described by Grossowics, Kaplan and Schneerson[1], and the active principle was called 'lactobacillin'[2]. The tests were done on agar buffered to *p*H 7·0 with 1 per cent phosphates to avoid false positive effects due to lactic acid[2,3]. Ritter has described similar experiments[4]. His strains were isolated in Switzerland from Emmenthal cheese and through his kindness they were included in this investigation. Most of our cultures have now been identified serologically by Dr. M. E. Sharpe as *Lactobacillus lactis*.

It was known from previous experience that inhibition observed on agar media needs to be confirmed by dilution assay, because toxic metabolic by-products are less likely to interfere with this type of assay[5]. The lactobacilli, which were initially cultured in milk, were therefore 'trained' to grow in a peptone–glucose medium supplemented with 'Tween 80' and malt extract. These culture fluids could not be sterilized without loss of activity, so that a dilution assay against *Staph. aureus* was devised by culturing the test organism in plain nutrient broth in which the lactobacilli failed to grow[2]. Average titres of 1/1,280 were obtained in these assays, and in similar assays against *Cl. butyricum* titres of 1/100 were frequently obtained.

Hydrogen peroxide was not at first suspected. The culture fluids which were obtained in the malt extract medium were tested for the presence of hydrogen peroxide by a modification of the method of Main and Shinn[6]. In our hands, this method detected as little as 0·0002 per cent hydrogen peroxide (2·2 μgm./ml.). The sensitivity of *Staph. aureus* to hydrogen peroxide was given as 10 μgm./ml. by Coulthard *et al.*[7]; our test organism was slightly more susceptible, being inhibited by 4 μgm./ml. Moreover, when the assays were done in freshly boiled media and each tube was placed under a seal of alkaline pyrogallol, titres of about 1/640 were still obtained.

Two strains were then selected for further work in an endeavour to obtain the inhibitory substance free from cells. A wide range of organic and inorganic solvents at different *p*H's was used, but without success. Later, we attempted by physical and chemical means to disrupt the cells. Microscopic examination showed this to be very difficult; but whenever some measure of success was obtained the antibiotic activity was lost. It then became clear that the activity was always associated with living, though not necessarily multiplying, cells. In an experiment designed to check this point, the number of viable organisms was progressively decreased by alternate freezing and thawing at decreasing temperatures (refrigeration, solid carbon dioxide and liquid air). A parallel decrease in the assay titres was observed. It thus appeared that the cells produced the inhibitory substance, possibly hydrogen peroxide, during the assay.

Catalase prepared from *Micrococcus lysodeikticus* by the method of Herbert and Pinset[8] and a commercial pig liver preparation both abolished the antibiotic effect when 0·001 per cent was included in a dilution assay. However, catalase inactivated by

adjusting to *p*H 2·5 and incubating at 42° C. for 2 hr. had no effect on the assay. Similarly, when catalase or fresh serum was included in the agar, no zones of inhibition were obtained. Pyruvate (0·01 per cent) also abolished the titre. In the 'anaerobic' assays which were done with tubes under a seal of alkaline–pyrogallol, all these substances were equally effective. It appears, therefore, that hydrogen peroxide is very readily produced by these strains of lactobacilli, even when only traces of oxygen are present. Hydrogen peroxide estimation in the actual assay tubes further confirmed these findings. In the last tube of these assays showing no growth, 4 μgm./ml. hydrogen peroxide was usually found, whether the assay was set up aerobically or 'anaerobically'. This figure agrees well with that previously found for the sensitivity of the test organism to hydrogen peroxide.

At this point all our strains were re-assayed by the dilution method against *Staph. aureus* with and without catalase in the medium. In all cases catalase abolished the inhibition.

It was still difficult to understand why the lactobacillus was some twenty-five times more resistant to hydrogen peroxide than the staphylococcus, being inhibited by 100–200 μgm./ml. As there is no catalase in lactobacilli, their much greater resistance could be attributed to destruction of hydrogen peroxide similar to that described by Seeley and Rio-Estrada with *Str. fæcalis*[9]. They found that aerated cultures of this organism developed a mechanism for utilization of hydrogen peroxide through riboflavin. In this case, however, we did not succeed in developing the adaptive mechanism, although in one series twenty-three consecutive sub-cultures were grown at 37° C. with vigorous shaking. When tested in a Warburg respirometer, the resting cells produced hydrogen peroxide from glucose whether they were grown on the shaker or under an anaerobic seal (see graph). In both cases catalase was stimulatory. At intervals estimations were made of the hydrogen peroxide in the contents of the Warburg flasks. In the absence of catalase, self-inhibitory levels of hydrogen peroxide (*c.* 120 μgm./ml.) were quickly reached and the rate of respiration declined. Further confirmation was obtained when hydrogen peroxide was added to resting cell suspensions and this was not decomposed. Finally, the sterile malt extract broth, but not other media, was found to contain an unidentified mechanism either for removing added hydrogen peroxide or masking the test. This explains the failure to find hydrogen peroxide in the culture fluids without affecting its presence in the assays, which were done in a simple nutrient broth.

It is possible that where these lactobacilli may naturally predominate, for example, in cheese, the hydrogen peroxide produced may have a beneficial effect. This part of the work is still in progress and full details will be published in due course. Meanwhile the evidence suggests that hydrogen peroxide is involved in the inhibitory mechanism and the name 'lactobacillin' is withdrawn.

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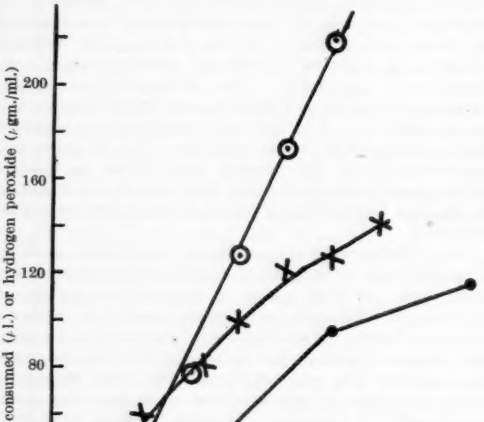

Aerobic consumption of oxygen and production of hydrogen peroxide by a strain of lactobacillus in a Warburg respirometer. Cells grown aerobically or anaerobically.
⊙, with catalase, oxygen consumption; ×, without catalase, oxygen consumption; ●, hydrogen peroxide produced.
Each flask contained 0·8 ml. of a cell suspension, 1 ml. *M*/15 phosphate buffer (*p*H 7·0), 0·2 ml. of catalase (0·1 per cent) or 0·2 ml. distilled water. 0·2 ml. 5 *N* potassium hydroxide in centre well and 0·5 ml. *M*/10 glucose in side arm. Total volume, 2·7 ml.

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Relationship between Reduced Glutathione Content and Spontaneous Hæmolysis in Shed Blood

Many enzymes contain sulphydryl groups essential to their activity; they are readily inactivated by oxidation. It is known that reduced glutathione protects them against oxidation[1]. In this respect hæmoglobin behaves in a similar manner to the 'SH-enzyme' in that its spontaneous oxidation to methæmoglobin is inhibited by glutathione[2].

It has been found that red cells in which all the hæmoglobin has been converted to methæmoglobin by sodium nitrite contain no reduced glutathione. When stored in the cold they hæmolyse spontaneously in apparently a shorter time than the normal cells[3]. These observations suggest that the hæmolysis of shed blood may be connected with methæmoglobin formation or with glutathione oxidation.

This communication gives an account of experiments which support the hypothesis that there is a

relationship between the rate of spontaneous hæmolysis and the extent of oxidation of glutathione, and that this relationship is not influenced by methæmoglobin formation. The spontaneous hæmolysis was studied in samples of whole horse blood (*p*H 7·4–7·5) or in horse red blood cell suspensions in Ringer solution containing glucose (*p*H 7·0). The samples were exposed to air, or an oxygen and nitrogen–carbon dioxide (6 per cent) mixture, at 20° C. or at 37° C. during a period of time ranging between 1 hr. and 24 hr. The concentration of extra-cellular hæmoglobin (converted to cyanmethæmoglobin) was determined spectrophotometrically (at 540 mμ), at intervals of time. Parallel determinations of reduced and, in some experiments, total glutathione were made by Woodward and Fry's method[4].

Blood exposed to oxygen for a period of time, ranging between 1 hr. and 6 hr., showed a more distinct hæmolysis than the blood exposed for the same period of time to air. The extent of hæmolysis in air or oxygen was increased on exposure to a temperature of 37° C. Under similar conditions, blood exposed to a nitrogen – carbon dioxide mixture showed no determinable concentration of free hæmoglobin.

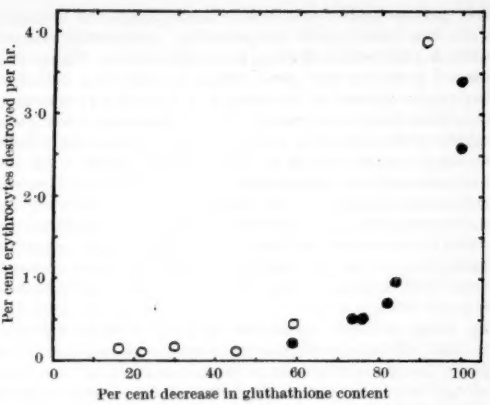
In samples exposed to air or oxygen, the reduced glutathione gradually decreased during the period of observation, and the extent of its oxidation for the same period of observation was distinctly greater in samples exposed to oxygen. Exposure, for the same period of time, to air or oxygen at 37° C. produced a more marked decrease in the glutathione content than exposure at 18° C. In deoxygenated samples, the amount of glutathione present after exposure of 15 min. was greater than that in aerated or oxygenated samples and did not change with further exposure.

No significant change in the total glutathione was found in blood exposed to air, oxygen, or to a nitrogen – carbon dioxide mixture. The amount of methæmoglobin found at the end of an observation period did not exceed 3 per cent of the total hæmoglobin content.

Another series of experiments was carried out to determine whether the elimination of reduced glutathione by oxidation with iodine would increase the rate of spontaneous hæmolysis. It was found that: (*a*) no immediate hæmolysis was produced by the addition of iodine in final concentration of 0·6–6·0 μ*M* in 1·0 ml. of blood or red blood cell suspension; (*b*) the decrease in glutathione content caused by iodine is related to the concentration of iodine added, and the glutathione reaches its lowest concentration (corresponding to the amount of iodine added) almost immediately after the addition of the iodine; (*c*) a complete oxidation of the glutathione could be achieved by the use of iodine, without any extensive formation of methæmoglobin (not more than 3 per cent of total hæmoglobin content); and (*d*) the rate of hæmolysis bears a certain relation to the extent of oxidation of the reduced glutathione.

The results of the six experiments in which iodine (solid circles) was used and the six experiments in which exposure to air or oxygen was employed (open circles) are given in the accompanying graph, in which the percentage decrease in reduced glutathione is plotted against the rate of hæmolysis determined from graphs.

The graph shows that there is no marked increase in the rate of hæmolysis until the glutathione content



drops to about 40 per cent of its mean initial value, when a further decrease in glutathione content is connected with a rapidly growing rate of hæmolysis. This relationship applies to hæmolysis in blood exposed to oxygen as well as to the blood treated with iodine. This suggests that in both procedures the spontaneous hæmolysis has a similar mechanism.

The results of these experiments suggest that glutathione plays an important part in the maintenance of the integrity of the structure and function of the erythrocyte and, perhaps, of all tissue cells.

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Improvements to the Melted Emulsion Technique of Autoradiography

The method whereby autoradiograms are obtained by covering histological sections with photographic emulsion[1] has been improved or modified for specific needs[2–7]. In our laboratory, the inversion technique[3] has gained considerably in definition and ease of operations by substituting the emulsion from Kodak High Contrast Positive film for that of Matrix film (Eastman Kodak Co.) which contains a yellow dye.

The emulsion from Kodak High Contrast Positive film is unstained. It is removed easily from the base under the relatively bright Series 0*A* 'Yellow-Green Safelight'. It is very fluid at 38° C. and does not retain air bubbles. It can be processed and washed at the usual temperature (20° C.). It has a better resolution (165 lines per mm.); shows fewer background artefacts, and can be used for contact, for coating stained specimens[1,2,5], or for unstained sections which are inverted and stained after the photographic processing[3].

The technique at present in use for tracer studies of the mineralization of bones and teeth is as follows. For contact autoradiograms, strips of 35-mm. film

are cut to appropriate size and placed in contact with the histological preparation, previously coated with 1 per cent celloidin in alcohol-ether. These are placed between two glass slides bound with cellulose tape and exposed in the dark at 4° C. After processing, the film strips are again bound between two glass slides with cellulose tape. This makes handling, storing, inspection and identification easy. In the melted emulsion technique, strips of 35-mm. film are cut to appropriate size (6–8 in.) and hydrated for a few seconds in distilled water, at room temperature. Each strip is then laid down on a glass plate, emulsion face up, and the emulsion is scraped from the central area with a glass slide. The emulsion is collected in a small beaker at 38° C. and, when melted, is picked up with a clean medicine dropper and transferred to the celloidin-coated microscope preparation. The practice of coating with a 'Blanchard brush'[3] has been altogether abandoned because it produces uneven coats and favours the production of air bubbles. The emulsion is then gelled and dried on a levelled glass plate, under a gentle air stream. The dry specimen is exposed in the dark at 4° C.

Development can be carried out at 20° C., but the cold bath (10° C.) for 10 min. gives less background fog and fewer artefacts. The formulæ *D*11 or *D*19, diluted 1 to 1 with distilled water at the time of use, give a more accurate picture than the previously used *D*72 ('Dektol').

The preparations are then rinsed in distilled water at 10° C., fixed for 10 min. in Kodak acid fixer with hardener also at 10° C. and finally washed under a gentle stream of tap water for 30 min. They can be dehydrated, cleared and mounted at this stage or inverted under water[3], remounted on a glass slide, section face up, and dried under a gentle air stream. For staining these inverted preparations, a 0·02 per cent aqueous solution of basic fuchsin is used, after passing through fresh oil of origanum and down-graded alcohol solutions to distilled water. Basic fuchsin solutions keep well and seem to gain strength when stored in glass-stoppered brown bottles; an older solution will stain well in 5 min., while a fresh one will require up to 10–15 min. Sections are transferred rapidly through 95 per cent alcohol, which differentiates and removes excess stain from the background. They are then passed through three baths of absolute alcohol. For clearing, oil of origanum is preferred to xylene or other light oils; it is messy but minimizes artefacts. Two baths are used and the preparations are finally mounted in 'Permount' (Fisher), using liberal amounts.

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Determination of Yeast Carbohydrates with the Anthrone Reagent

A paper on this subject by Fales[1] has recently appeared; almost simultaneously, we described a more extensive fractionation of yeast carbohydrates, using also the anthrone reagent for colorimetric determinations of total cell carbohydrate as well as of the individual fractions[2]. Considerable interest has been shown in this technique, as judged by the volume of correspondence we have received. As the original procedure was adapted to the small amounts of yeast used in manometric experiments on fermentation[3] and requires considerable manipulative skill and time, we wish to put on record the following adaptation which can be used when larger quantities of yeast are available for analysis. The dilutions of the various fractions are designed to give about the same optical density in the anthrone reaction as a standard solution containing 100 μgm. glucose/ml., when D.C.L. baker's yeast is used; other yeasts may require some adjustment in this respect.

The yeast to be analysed is suspended in water (50 mgm. wet weight/ml.).

Total carbohydrate: dilute to 1 mgm./ml. and determine as described[2].

Extracellular carbohydrate: centrifuge 10 ml. suspension (500 mgm.) and determine carbohydrate in the supernatant.

Acid-soluble carbohydrate (trehalose): suspend the residue in 3 ml. trichloroacetic acid (100 gm./lit.). After five minutes, transfer the suspension to a volumetric flask and make up to 50 ml. Mix, and stand for 5 min. Centrifuge 10 ml. (100 mgm. yeast) in a 15-ml. conical tube and determine trehalose on a 1 : 1 dilution of the supernatant. The residue from the alkaline extraction (see below) is not easily centrifuged, hence the use of the small conical centrifuge tube at this stage.

Alkali-extractable carbohydrate (mannan plus glycogen): wash the residue in the centrifuge tube with water twice. Suspend the washed acid-extracted cells in 1 ml. potassium hydroxide solution (300 gm./lit.) and heat 30 min. in a water-bath at 100° C. Cool, centrifuge, and pour the supernatant into a 10-ml. calibrated flask or cylinder: wash the residue by successive suspension in water and centrifuging, and make supernatant and washings to 10 ml. Dilute an aliquot 1 : 1 with water and determine mannan plus glycogen extractable by alkali.

Mannan: add 2 ml. Fehling's solution to 5 ml. of the alkali extract (≡ 50 mgm. yeast) contained in a 15-ml. conical centrifuge tube. Warm in the water-bath, and shake until the mannan copper complex is precipitated. After standing an hour or so, centrifuge and wash with dilute alkali (0·1 *N* sodium hydroxide). Dissolve the copper complex by adding sulphuric acid (few drops 10 *N* acid), transfer to a volumetric flask and make to 10 ml. When carrying out the colorimetric determination use two standards: glucose 100 μgm./ml., mannose 150 μgm./ml. in order to correct for the lower chromogenic value of mannose[2].

Acid-extractable polysaccharide (glycogen): suspend the residue from the alkali extraction in 2 ml. 2 *N* sulphuric acid, and heat 15 min. on the water-bath at 100° C. Cool and centrifuge; wash the residue with water, and make supernatant and washings to 15 ml. (6·67 mgm. yeast/ml.).

Glucan: add dropwise sulphuric acid (2 acid : 1 water) to the well-drained and chilled residue,

stirring with a fine glass rod. As soon as the material dissolves, instantly dilute with a large volume of cold water, and transfer the milky fluid, making to 15 ml. with water (6·67 mgm. yeast/ml.).

It will be seen that the alcohol precipitation steps of the previous procedure[2] have been eliminated, saving time; and that the glucan is obtained in aqueous solution or fine suspension, which is more easily pipetted than the anthrone reagent used in the original method[2]. Results obtained by the two procedures are in agreement.

Note added in proof. A simpler method of treating the glucan precipitate is to add a few drops of potassium hydroxide solution (300 gm./lit.) and stir with a glass rod, when the glucan disperses and can be diluted to give a stable suspension suitable for direct pipetting.

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April 8.

[1] Fales, F. W., *J. Biol. Chem.*, **193**, 113 (1951).
[2] Trevelyan, W. E., and Harrison, J. S., *Biochem. J.*, **50**, 298 (1951).
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Refection in the Common Shrew

Refection or 'coprophagy' has been observed in the rabbit[1] and in certain other rodents, including the house-mouse and brown rat[2]; but there appear to be no records of its occurrence in the Insectivora. The habit has now been observed in juveniles and adults of both sexes of the common shrew, *Sorex araneus* Linn.

The animal adopts a curled-up position upon its side or back, within the nest, parts the hind-limbs and begins to lick the anus. Some individuals grip the hind-limbs with the forefeet in order to maintain this attitude. After a few seconds a rapid series of abdominal contractions brings about the gradual eversion of the rectum. It emerges as a stout firm tube, 5–10 mm. long, which curves slightly forward towards the mouth. The open end of the everted rectum is nibbled and licked for a period which has not been observed to exceed ten minutes. Inversion into the body, like eversion, is effected by abdominal movements. If the animal is picked up without warning, the everted rectum may lose its 'erected' condition and become flaccid.

When the animals are dissected immediately after refection, the stomach and the first few centimetres of the intestine are found to be filled with a milky fluid containing numerous fat globules and small fragments of undigested food. The remainder of the intestine and the rectum are completely empty. It is evident that refection does not commence until the gut is entirely free of fæcal matter. Possibly the brief anal lickings frequently observed prior to refection are directed towards sampling the rectal contents.

Harder[2] reviews present knowledge of refection in rodents, and proposes the term 'cæcotrophy' to replace 'coprophagy', in view of the cæcal origin of the ingested material. While refection in the shrew may imply analogous nutritional consequences, the mechanism involved must be quite different as no cæcum is present. The process may be a relatively simple one, brought about by a periodic cessation in the flow of digestive fluids. Its occurrence in recently weaned juveniles and in adults soon after capture suggests that it is a normal physiological process rather than one occasioned by diet deficiency in captivity.

These observations were made while engaged on an ecological study of the species at the Bureau of Animal Population, Department of Zoological Field Studies, University of Oxford.

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[1] Taylor, E. L., *Nature*, **143**, 982 (1940). Eden, A., *Nature*, **145**, 36 (1940). Southern, H. N., *Nature*, **145**, 262 (1940); **149**, 553 (1942).
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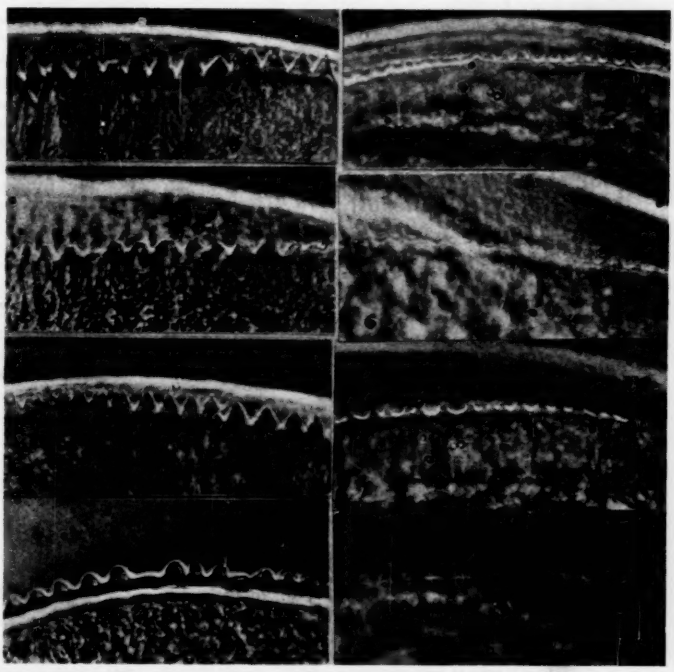
Anatomical Distinction between Human and Pig Strains of *Ascaris*

It has long been a matter of uncertainty whether the ascaris parasite of the domestic pig is specifically identical with *Ascaris lumbricoides* L. 1758 from the



Pig Man

Denticles of *Ascaris* of pig and man. × 750

intestine of man. The evidence, as brought forward by epidemiological observations and by experimental infections, appears on the whole to indicate that there is a difference in these two parasites; but no morphological feature has been discovered which distinguishes them as separate species.

Through the kind co-operation of Dr. P. C. Beaver, of Tulane University, U.S.A., I have recently examined, while working at the Ontario Research Foundation, about fifty well-preserved specimens of the human ascaris removed from the intestine of a child at operation. The denticles of the dentigerous ridges were compared with those of the pig ascaris obtained from an abattoir in Toronto. Comparisons were made of *en face* and internal views of the lips both in the glycerine- and creosote-cleared specimens. Both sexes were examined in about equal numbers.

The photographs (reproduced herewith) show that the denticles of the pig ascaris (Figs. 1–4) form a conspicuous row of more-or-less equilateral triangles and that the edges of the denticles are straight. In contrast, the denticles of the human ascaris are considerably less conspicuous, being smaller and having concave edges (Figs. 5–8). In some specimens of the pig ascaris the points of the denticles are rounded, possibly by wear, but the difference is still apparent (Figs. 2 and 4). In some specimens of the human ascaris, the denticles appear to be worn away, only the ridge being evident.

The purpose of this communication is to suggest that specimens from other parts of the world should be examined with regard to their denticles, so that the taxonomic value of these structures may be ascertained.

I should be grateful to receive any ascaris material.

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An Improved Electrophoresis Cell for the Analyses of Several Sera Simultaneously

An electrophoresis cell which enabled two sera to be analysed simultaneously was described in a previous communication[1]. In this apparatus two 'Cellophane' membranes were inserted between the top and the bottom of the standard analytical cell and the electrode vessels.

A new apparatus embodying the same principle but giving diagrams identical with those obtained by the conventional method is depicted in Fig. 1. *A* and *B* are 'Perspex' adaptors connected to the electrode vessels, *C* is the central part of a standard Longsworth cell and *D* is a slotted 'Perspex' slide which can cut off communication between *A* and the cell when desired. Prior to assembly, the ground surfaces of the 'Perspex' and glass are well greased and a 'Cellophane' membrane *M* is clamped between *B* and the cell *C*. The balance of the apparatus is then assembled and the sera to be analysed introduced via the slots in the bottom of adaptor *A* and the levelling section. The levelling section is then moved to the cut-off position, the excess serum removed and the rest of the cell filled with buffer and a saturated solution of potassium chloride.

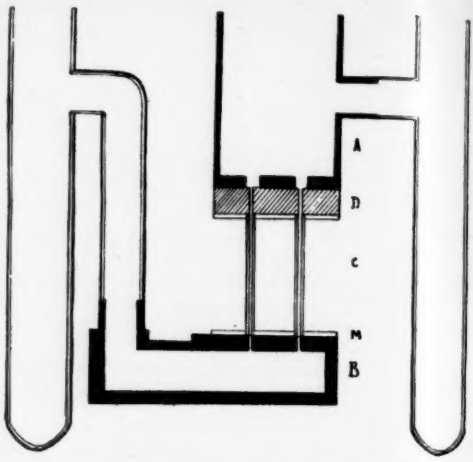

Fig. 1. Electrophoresis cell. The two electrode vessels are connected via the adaptors *A* and *B* to the standard Longsworth cell *C*. *D* is a 'Perspex' slide which can cut off communication between *A* and *C*. *M* is a 'Cellophane' membrane clamped between *C* and *B*

After temperature equilibrium has been established in the electrophoresis bath, a fine Pasteur pipette with its tip bent horizontally is lowered, through chamber *A* and the slots in the levelling section, into the cell, and fluid is drawn off at the required level. A very sharp interface is thus established at this position between the serum and the buffer. This method of boundary sharpening has previously been used in electrophoresis and diffusion measurements[2,3]. The current is now switched on and electrophoresis performed in the usual way.

As mentioned in the previous communication[1], there is no theoretical limit to the number of compartments which can be introduced into the analytical section, and consequently to the number of analyses which can be performed simultaneously.

Electrophoresis diagrams obtained with the new apparatus are shown in Figs. 2,*a* and *b*. Fig. 2,*a* is the diagram of normal serum and is free from the anomaly found in diagrams made with the earlier form of the apparatus. Fig. 2,*b* shows diagrams of

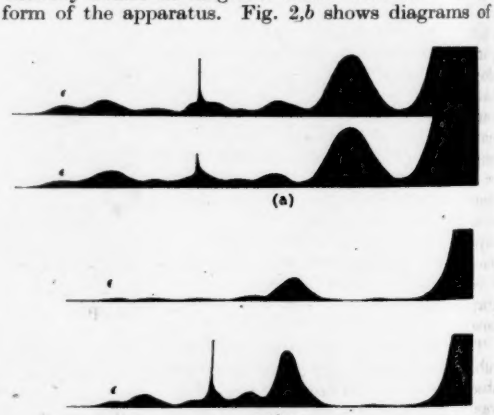

Fig. 2. (*a*) Two electrophoresis diagrams of the same serum run simultaneously in the two limbs.

(*b*) Electrophoresis diagrams of the serum and urine of a patient with orthostatic albuminuria run simultaneously. The urine was concentrated eight times before electrophoresis

the serum and urine of a patient with orthostatic albuminurea.

An electrophoresis cell is now under construction which will allow four electrophoretic analyses to be performed simultaneously. With this type of cell the sera may be removed by a long pipette after a run and immediately replaced by a second batch of four samples. In this way we hope to be able to analyse at least eight sera during the course of a normal working day.

The Virus Research Unit in which this work was carried out is financed by the South African Council for Scientific and Industrial Research with additional grants from the Nkana-Kitwe and Chingola Poliomyelitis Research Funds.

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Feb. 11.

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Structure of White Phosphorus: Single Crystal X-Ray Examination

Several attempts to obtain X-ray diffraction patterns of crystalline white phosphorus have been made[1]. It is claimed by some that the ready reversion of the white to the red form under irradiation with X-rays prevents any pattern being obtained, while others suggest that the high degree of thermal motion in the crystal lattice will render it impossible to obtain anything but a few very diffuse rings. Natta and Passerini[2], however, state that they obtained a well-defined powder photograph of white phosphorus with 22 lines, using iron $K\alpha$ radiation at $-35°$ C. They claim that the substance is cubic with $[a] = 7{\cdot}17$ A., containing four molecules of P_4 per unit cell, but give no other data.

By using copper $K\alpha$ radiation at $-30°$ C., we have obtained X-ray diffraction patterns from single crystals of white phosphorus. Our results do not confirm those of Natta and Passerini. Sticks of highly purified white phosphorus were sealed in glass tubes under vacuum and crystals grown by slow sublimation. A wide variety of crystalline habit was observed. Needles, rectangular plates and various polyhedra were obtained, all of which gave similar X-ray patterns. It was found that these single crystals would remain stable, usually for two or three days, if they were given a thin coating of methanol-shellac solution. The crystals were cooled in a stream of dried air at $-30°$ to $-35°$ C. during exposure, and well-defined oscillation and rotation photographs were obtained on a standard camera of 3 cm. radius. Attempts to obtain powder photographs using Natta and Passerini's technique[2] were unsuccessful.

The X-ray photographs indicated a body-centred cubic lattice with $[a] = 18{\cdot}51 \pm 0{\cdot}03$ A. Systematic absences of the reflexions were $\{hkl\}$ when $\{h+k+l\}$ was odd. A Laue photograph revealed the presence of a fourfold axis of symmetry, and this meant the space group was probably 1432, $14\bar{3}m$ or $1m3m$. The crystal density at $-25°$ C. was found to be 1·84 gm./c.c. A unit cell containing 56 P_4 molecules gave a calculated density of 1·82 gm./c.c. The general features of the photographs included, in addition to single crystal spots, weaker diffuse rings corresponding to spacings of roughly 4·3, 2·5 and 1·7 A. Evidence for a high degree of thermal motion in the structure was afforded by the very rapid decrease of the intensities of the diffraction spots after a value of about $\rho = 1{\cdot}0$.

It is reasonable to suppose that the structure is built out of discrete tetrahedra similar to those which exist in the vapour[3], with $P - P = 2{\cdot}21 \pm 0{\cdot}02$ A. and angles $P\widehat{P}P = 60°$. Preliminary structural studies with the aid of similar tetrahedral models indicated that 56 P_4 molecules could not be arranged in the unit cell without appreciable mutual overlap, if the non-bonded radius of the phosphorus atom was taken[4] to be 1·9 A. An explanation of the structure may be found in some peculiar effect of the thermal motion on the packing arrangements. Space group $1m3m$ could be rejected as very improbable on general crystallographic grounds, and $14\bar{3}m$ seemed a more likely choice than 1432. Further examination of the crystal structure is proceeding and detailed results will be published elsewhere.

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April 10.

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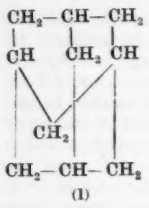
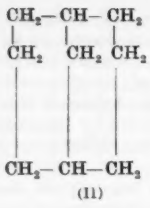
Thiaadamantane

The investigation into the composition of the sulphur bodies present in the kerosene boiling-range of a Middle East crude oil distillate (Agha Jari, South Iran) has indicated that the sulphuric acid-soluble neutral compounds consist mainly of fully hydrogenated mono- and bi-cyclic sulphides with smaller amounts of alkylated thiophenes. A solid sulphur-containing compound is also present which collects as a sublimate in the column head during the fractionation when the column head reaches 78° C. at 3 mm. mercury pressure. This solid can be purified by sublimation or recrystallization, and forms sweet-smelling crystals which melt in a sealed tube at 320° C. with decomposition. Analysis gives the empirical formula $C_9H_{14}S$.

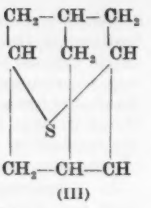
The general character of this interesting compound together with its chemical reactions, which include the formation of a sulphone and a mercuric chloride complex, suggests that it is a doubly bridged *cyclo*-paraffin in which a sulphur atom forms one bridge. In its physical properties this compound resembles the hydrocarbon adamantane isolated by Landa and Macháček from a Hodonin naphtha[1]. The structure of this hydrocarbon, confirmed by synthesis (Prelog and Seiwerth[2]), is that of a doubly bridged *cyclo*-octane ring (I). Confirmation that our sulphur body contains a basic structure resembling that of adamantane is shown by the fact that, on desulphur-



(I)



(II)



(III)

ization with Raney nickel, it yields bi*cyclo*-1.3.3-nonane (II).

While it is possible that the sulphur occupies alternative positions in the adamantane structure and that desulphurization still yields the same bi*cyclo*nonane, from the general character of our compound it appears highly probable that the sulphur forms the second bridge spanning the 3.7-carbon atoms (III). An attempt is being made to confirm this structure by synthesis. The isolation of this compound together with that of the bicyclic sulphides and thiophenes which accompany it will be fully reported in due course elsewhere.

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[1] *Coll. Trav. chem. Tchecoslovaquie*, **5**, 1 (1933).
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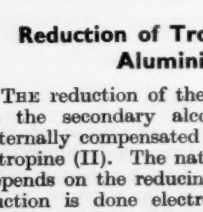
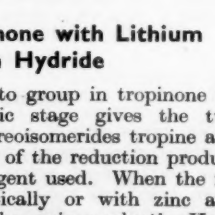
Reduction of Tropinone with Lithium Aluminium Hydride

The reduction of the keto group in tropinone (I) to the secondary alcoholic stage gives the two internally compensated stereoisomerides tropine and ψ-tropine (II). The nature of the reduction product depends on the reducing agent used. When the reduction is done electrolytically or with zinc and hydriodic acid, tropine is the main product[1]. However, the reduction product is always contaminated with small amounts of ψ-tropine. With sodium amalgam tropinone is reduced to ψ-tropine only[1]. As the formation of tropine and ψ-tropine from tropinone involves the reduction of a ketone to a secondary alcohol, it could be foreseen that lithium aluminium hydride would be a specific reagent for it[2]. However, the interest lay in knowing the exact nature of the reduction product (or products) obtained.

Reduction of tropinone was studied in ether solutions. In all the experiments ψ-tropine was



(I)



(II)

obtained and the yield was quantitative. Difference in the concentration of the solution, in the rate of addition, or reverse addition, made no change in the nature of the reduction product. A range of temperatures from − 10° to the boiling point of ether made no difference. In all the experiments, the product was isolated in the form of the picrate to ensure the separation of tropine and ψ-tropine[1,3].

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Feb. 17.

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A New Province of Igneous Ring-Complexes in Southern Nyasaland

Recent examination of air photographs of Southern Nyasaland taken by the Royal Air Force has revealed that almost certainly this area forms a province of igneous ring-complexes, vents and dykes comparable with the British Tertiary igneous area of West Scotland, the White Hart Mountains region of New Hampshire and the more recently described region of ring intrusions in Nigeria. Indeed, it seems probable that the number of vents and ring-complexes in Southern Nyasaland and the adjoining parts of Portuguese territory will exceed that of any previously reported area.

From Dr. F. Dixey's work[1] on the Nyasaland Geological Survey, it has long been known that vents filled with agglomerates and the much-discussed carbonatites exist in the region of Lake Chilwa, and it now appears likely that these form one manifestation in a complete igneous episode involving, in order of time, great outpourings of lava, the explosion of volcanic vents, probable cauldron-subsidence and the intrusion of ring-dykes and great syenite stocks and, lastly, the injection of basic dykes. The Stormberg period at the close of Karroo times was characterized by the extrusion of tremendous lava flows over a very large area in Central and South Africa, and Dr. Dixey has been able to date the volcanic vents of Southern Nyasaland as being post-Karroo and pre-Cretaceous. Further, it is known that the nepheline syenite intrusions into the vents are later than the agglomerates and carbonatites and, while the great ring-dyke complexes now reported have not yet been dated, there is very good reason to suppose, from analogy with other areas, that they follow on, in time, after the explosive vents and were themselves followed by the dyking phase.

One very spectacular ring-dyke complex forms Chambe Plateau in the north-western part of the Mlanje Mountains; it is thought to comprise four successive ring-dykes about the same centre and with a common vertical axis. The external diameter of the outermost dyke is just over four miles. From the plains at the foot of the mountains the two outer 'rings' rise almost sheer for 6,000 ft. in places, while the two inner 'rings' form a central circular depressed region some 2,000–2,500 ft. below the outer 'rampart'.

The facts observed on the photographs and the hypotheses formed therefrom must, of course, be checked in the field before this potentially important region can be discussed in detail; but the recognition

of the ring complexes and dykes from air photographs forms a striking example of the value of photogeological interpretation. Work on the photographs continues at the headquarters of the Directorate of Colonial Geological Surveys.

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April 17.

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Rapid Estimation of Standard Deviations

When a series of numbers can legitimately be regarded as random samples from a normal distribution, the mean range within small sub-groups, multiplied by a factor depending only on group-size, gives a very good and easily calculated estimate of the standard deviation of the parent distribution, not much inferior in precision to that obtainable from the mean squared deviation[1]. A specially simple computation is obtained when the sub-group size is two.

Let the successive individual readings be A, B, C ... X, Y, Z. The sum is required of all the ranges between adjacent numbers. This means that all the differences, $(A - B)$, $(B - C)$, and so on, are to be given a positive sign and added together. If B is greater than both A and C, it will have a positive sign twice. If B is less than both A and C, it will have a negative sign twice. But if B is bigger than one neighbour and smaller than the other, it will take one positive sign and one negative sign, and so will cancel out. The sum of the sub-group ranges, therefore, is twice the sum of the peak numbers (bigger than both neighbours) minus twice the sum of the trough numbers (smaller than both neighbours). This rule obviously breaks down for the terminal numbers A and Z. To deal with this, regard the series as an endless cycle, going back to A after reaching Z, and write the first two numbers again at the end, thus: X, Y, Z, A, B. It is then possible to see whether Z and A are peaks, troughs or intermediate, and to add, subtract or ignore them accordingly. When two or more adjacent numbers are identical, disregard all except the first and treat that by the regular rule. If there are N items in the series, there are also this number of sub-ranges. The factor for converting range into standard deviation for binary groups is 0·886, which can be taken as eight-ninths. Hence the following rule:

To estimate the standard deviation of a random series from a normal distribution, add all the peak numbers and subtract all trough numbers in the series with the first two members repeated at the end, divide by $\frac{1}{4}N$, and take off one-ninth.

The peak–minus–trough values can usually be found mentally, and may be written down and added. On a machine, the peak and trough totals can be found simultaneously, and the difference between them can then be obtained.

Range methods for standard deviation have been shown[1] to continue to give quite good approximations even when the distribution differs markedly from the normal. But the estimate may be seriously distorted if the data are not in random order. Any marked trend, whether upwards, downwards or cyclical, or any circumstance which causes adjacent values to be more closely alike or more unlike than would happen by chance, will produce bias in the estimate. In doubtful cases, there is a useful simple test of randomness. For large N, the number of peaks (or troughs) in a random series may be regarded[2] as normally distributed with mean $N/3$ and standard deviation $(N/22\frac{1}{2})^{1/2}$. The difference between actual and expected number of peaks is tested for significance in the usual way. If the discrepancy is D, there is no evidence, at the 95 per cent probability-level, of departure from randomness so long as D^2 is not larger than $N/5{\cdot}86$, or, to a sufficient approximation, not larger than $N/6$. When there are many 'ties' between adjacent observations, the number of these should be subtracted from N before the test for randomness is applied.

In practice, moderate departures from randomness do not invalidate the estimate of standard deviation, provided this method is recognized as giving only a quick approximation. It will often suffice to settle questions of significance without need for recourse to the maximally efficient but much more laborious computation based on sums of squares. It may also be used as an independent check of standard deviations calculated in the orthodox way. If this is done, the computer will soon gain experience of the effect of departure from randomness on the estimate of standard deviation. When the departure from randomness is serious, the method may still be applicable provided it is not difficult to shuffle the data so as to get nearer a chance order. It may suffice, for example, to read the data across rows instead of down columns. The method is specially useful for data recorded on control charts. It can also be used to get a pooled estimate from sets of observations presumed to have the same standard deviation though their means may differ, such as arise in biological assay. The peak–minus–trough figures are totalled over all the series, and treated as if they came from one series with ΣN observations.

To obtain the mean, make a separate total of the intermediate numbers (neither peak nor trough) and add to the peak and trough sums to get the grand total. All three totals can be computed simultaneously on the usual kinds of machine. An easier method, which gives the mean and a rather less precise estimate of the standard deviation, is to take the observations in non-overlapping pairs and to add separately the larger and the smaller numbers. Thus A and B would first be considered, then C and D, and so on, the smaller of each pair being accumulated on the left, and the larger on the right, of the machine. If N is even, the sum of the totals divided by N gives the mean, and the difference, divided by $\frac{1}{2}N$ with one-ninth deducted, gives the estimate of the standard deviation. If N is odd, the last observation may be omitted for computation of the standard deviation, or it may be paired with the first, the divisors being respectively $\frac{1}{2}(N - 1)$ or $\frac{1}{2}(N + 1)$. For computing the mean, every observation is, of course, taken once.

The methods described above are specially rapid on key-driven adding machines.

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March 17.

[1] Cf. Pearson, *Biometrika*, **37**, 88 (1950).
[2] Kermack and McKendrick, *Proc. Roy. Soc., Edin.*, **57**, 228 (1937).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 13

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. Adrien Albert: "Ionisation and Biological Activity".* (Further Lectures on October 20 and 27.)

Physical Society, Acoustics Group (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Mr. A. T. Pickles: "Acoustics in America".

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. D. Mackay: "An Artefact's Approximation to Voluntary Behaviour".

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. E. M. Landis: "Movement of Fluid and Dissolved Substances through the Capillary Wall", 1.* (Further Lectures on October 15 and 17.)

University of London (in the Botany Department Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 5.30 p.m.—Prof. G. Melchers: "Physiology of Flower Formation".* (Further Lectures on October 15 and 17.)

Society of Chemical Industry, Fine Chemicals Group (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7 p.m.—Prof. F. E. King: "Synthesis of Simple Peptides".

Tuesday, October 14

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. A. Armitage: "Copernicus and the Reformation of Astronomy".*

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. D. M. Newitt, F.R.S., Dr. J. F. Richardson, Dr. R. H. Clark and Mr. D. E. Charles: "Pneumatic Conveying, Part 1, The Pressure Drop during Horizontal Conveyance".

Illuminating Engineering Society (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Dr. W. J. Wellwood Ferguson: Presidential Address.

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of Chemistry to Engineers" (to be opened by Dr. J. E. Garside).

Wednesday, October 15

Royal Sanitary Institute (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. W. F. B. Shaw: "The Efficiency of Domestic Solid-Fuel Appliances".

Physical Society, Colour Group (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Dr. E. N. Willmer: "Central Foveal Colour Vision"; Mr. R. A. Weale: "Colour Vision in Extrafoveal Regions".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Howel Williams: "Progress and Problems in Volcanology" (William Smith Lecture).

Royal Society of Medicine, Comparative Medicine Section (at 1 Wimpole Street, London, W.1), at 5 p.m.—Dr. C. L. Oakley: "The Sites of Production of Antibodies" (Presidential Address).

Textile Institute, Lancashire Section (joint meeting with the Newcomen Society, at the Textile Institute, Manchester), at 6.30 p.m.—Mr. W. A. Hunter: "James Hargreaves and the Invention of the Spinning Jenny".

Thursday, October 16

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Helen Spurway: "Is Man a Domestic Animal?"*

Society of Chemical Industry, Microbiology Group (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 2.30 p.m.—Mr. H. Proom and Dr. A. J. Wolwod: "The Application of Paper Chromatography to Microbiology".

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. J. B. Richardson: "Graduates in Metal Mining—Notes on their Status, Training and Vocation"; Mr. R. S. Cooke: "Recovering a Flooded Shaft in the O.F.S. Goldfield".

Physical Society, Low-Temperature Group (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Dr. A. J. Barnard: "Gas Compressors".

Society of Chemical Industry, Road and Building Materials Group (at the Building Centre, Store Street, London, W.C.1), at 6 p.m.—Dr. A. C. Whiffin and Mr. W. I. J. Price: "Road Problems arising from Snow and Ice".

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the Institute of Biology and the London and Home Counties Branch of the Institute of Physics, at the City of London School, Victoria Embankment, London, E.C.4), at 6.30 p.m.—Discussion on "The Place of the Scientist in Civil Defence".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Dr. D. H. R. Barton: "The Stereochemistry of *cyclo*-Hexane Derivatives" (Tilden Lecture).

British Institute of Radiology (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Mr. J. W. McLaren: "Some Aspects of Soft Tissue Radiography" (Presidential Address).

Friday, October 17

British Mycological Society (in the Physics Lecture Theatre, Birkbeck College, Malet Street, London, W.C.1), at 10.45 a.m.—Papers on "The Physiology of the Host-Parasite Relationship in Fungi and Bacteria".

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting; Rear-Admiral A. Day: "Navigation and Hydrography" (Presidential Address).

University of London (in the Chemistry Department, University College, Gower Street, London, W.C.1), at 4.30 p.m.—Seminar on "Polymer Science".* (Further Lectures on October 24, 31, November 7, 14, 21, 28, and December 5.)

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Sir David Pye, F.R.S.: "The Art of the Practical Engineer" (Presidential Address).

Royal Institute of Philosophy (at University Hall, 14 Gordon Square, London, W.C.1), at 5.30 p.m.—Prof. J. Z. Young, F.R.S.: "Mind and its Place in Nature" (Manson Lectures, 1). (Further Lectures on October 24 and 31, November 7, 14 and 21.)

Institute of Physics, Industrial Radiology Group (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. L. Mullins: "The Physics of the Radiographic Image".

World Calendar Association, British Section (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Calendar—Past, Present and Future".* (Admission by ticket from 20 Buckingham Street, London, W.C.2.)

Saturday, October 18

Nutrition Society (at Bedford College, Regent's Park, London, N.W.1), at 10.15 a.m.—Conference on "Unusual Foods for Human Consumption".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Honours Graduate (first- or good second-class) for cytogenetical research on tuberous species of Solanums, and an Assistant Experimental Officer (woman) for investigations of Late Blight and general maintenance of potato collection, at the Potato Genetics Station, Cambridge—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (October 17).

Assistant Lecturer in Electrical Engineering, to teach light current electrical engineering to H.N.C. and, possibly, final B.Sc. standard—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (October 18).

Experimental Officer to undertake research work connected with the application of strain gauge techniques to agricultural engineering problems, and in particular, to investigate with the aid of mobile strain recording equipment the dynamic forces within implements and tractors working on hillsides—The Secretary, Scottish Machinery Testing Station, Howden, Mid Calder, Midlothian (October 18).

Principal Lecturer in Electrical Engineering—The Registrar, Military College of Science, Shrivenham, Swindon, Wilts (October 18).

Head of the Department of Biology—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (October 20).

Pathologist at the Equine Research Station, Newmarket, a Pathologist at the Canine Research Station, near Newmarket, a Pathologist at the Poultry Research Station, St. Ives, a Bacteriologist at the Canine Research Station, a Parasitologist at the Equine Research Station, an Experimental Surgeon at the Equine Research Station, a Field Officer at the Farm Livestock Research Station, and a Nutritionist at the Poultry and Farm Livestock Research Station—The Scientific Director, Animal Health Trust, 232–235 Abbey House, Victoria Street, London, S.W.1 (October 20).

Senior Administrative Officer (experience of council and committee work is essential, and preference will be given to a graduate in natural science)—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (October 21).

Biochemist (non-medical) (with a university degree or equivalent science qualification)—The Group Secretary, Durham Hospital Management Committee, Dryburn Hospital, Durham (October 25).

Lecturer in Natural Philosophy—The Secretary, The University, Edinburgh (October 25).

Scientist III (with a good honours degree, or equivalent qualification, in a science subject, preferably with a sound background in geology and chemistry) in the Coal Survey Laboratory at Cardiff—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/538 (October 25).

Assistant Lecturer or Lecturer in the Department of Metallurgy—The Registrar, The University, Liverpool (October 27).

Lecturer in the Department of Botany at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, November 15).

Lecturers in Physiology at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 15).

Assistant Silviculturist (with a degree in forestry; practical experience in silvicultural research and biometry would be added qualifications) in the Wattle Research Institute of the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

Chief Scientific Officer in the Fisheries Research Unit attached to the Department of Biology, University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 1).